10 PRACTICAL APPLICATIONS OF SLINGS AND SPLINTS

10.1 Introduction

This chapter describes the application of slings and splints. Most splints used by Australian Ski Patrols are covered at date of publication. The application methods described herein are for guidance only. It is not expected that every patroller must apply splints according to these procedures.

It is expected, however, that:

- the principles of the management of fractures described in Chapter 8 **Fractures, dislocations and sprains** are applied; and
- when a splint or sling is applied it is done in a professional and competent manner, thus reassuring the casualty.

For more details of how to tie the knots referred to in this chapter, see Chapter 18 **Practical applications of knots**.

10.2 Slings

10.2.1 THE ARM SLING

Use:

This sling is used for all lower arm injuries between the elbow and fingertips except in the cases of severe bleeding. It may also be used for fractured ribs, with padding over the ribcage and broad bandages swathing the arm against the injured side. It can be used in conjunction with the SAM™ splint.

Application:

Step	
1	Check the tissue perfusion and distal pulses in the injured arm before moving the arm into position for the sling application.
2	Place the injured arm across the body of the casualty by holding the elbow at the side and positioning the forearm at about 90 degrees to the upper arm
3	Fully open a triangular bandage. Slide one end of the triangle up between the arm and the body with the apex of the bandage behind the elbow
4	Pass the top of the bandage up over the uninjured shoulder and around the back of the neck so that the point lies over the front of the injured shoulder
5	Slide the base of the bandage further in between the injured arm and the body until the edge just covers the tip of the little finger
6	Fold the bottom point up over the injured arm and tie the two points together with a reef knot so that the knot lies in the hollow just above the collar bone on the injured side. Tuck in the loose ends

7	The apex of the triangle is then pinned or tied in front of the sling to support the elbow
8	Check that circulation and tissue perfusion have not been altered by application of the sling and adjust the splinting and/or angle of the arm in the sling if the circulation has been compromised

The fingers should be exposed to allow the circulation to be monitored. The injured arm should be supported throughout the procedure by the casualty or an assistant.

Figure 153 Arm sling: place injured arm at 90 degrees to upper arm

Figure 154 Arm sling: position triangular bandage between injured arm and body

Figure 155 Arm sling: the reef knot above the collar bone on the injured side

Figure 156 Arm sling: check the circulation before and after application

10.2.2 THE ELEVATION SLING

This sling is also referred to as the 'Body Sling' or 'St John Sling'.

Uses:

- To elevate the lower forearm or hand, especially in the case of severe bleeding and finger injuries;
- as a splint for injuries or fractures to the shoulder blade, upper ribs, and clavicle; or
- fractured thumb, after bandaging.

Application:

Step	
1	Check the tissue perfusion and distal pulses in the injured arm before moving the arm into position for the sling application.
2	By holding on to the elbow and moving the hand, place the forearm diagonally across the chest with the casualty's fingers pointing towards the shoulder of the uninjured side and close to the collar bone
3	Place a triangular bandage over the injured arm with the point of the triangle directed past the elbow. The upper edge of the bandage should be parallel to and even with the top of the forearm
4	Carefully pass the base of the bandage well up under the injured arm so that the arm lies in a channel formed by the triangle
	Twist the lower edge and point of the triangle together and then wrap these around the casualty's back up to the uninjured shoulder
6	Tie the two ends together with a reef knot that should lie in the hollow above the collar bone of the uninjured side
7	If necessary, pin the base of the pocket that the arm is now lying in to support the elbow.
8	Ensure that the tips of the fingers are exposed to enable the circulation to be checked. This sling is more likely to compromise the circulation than the arm sling because the angle at the elbow is greater.
9	Check for tissue perfusion and the radial pulse and if altered, readjust the sling to reduce the angle at the elbow.

Figure 157 Elevation sling: Place injured arm across chest, pointing toward uninjured shoulder

Figure 158 Elevation sling: Place bandage over injured arm with point towards elbow

Figure 159 Elevation sling: Form channel for arm and twist ends of bandage

Figure 160 Elevation sling: Wrap bandage ends round casualty's back and tie with a reef knot on uninjured side

Figure 161 Elevation sling: Check circulation. Fingers should be exposed.

10.2.3 COLLAR AND CUFF SLING

Uses:

For injuries to the upper limb above the elbow.

The collar and cuff sling permits gravity to exert passive traction when required.

Application:

Step	
1	Check the tissue perfusion and distal pulses in the injured arm before moving the arm into position for the sling application.
2	Place the injured arm across the body of the casualty so that the fingers point towards the opposite armpit.
3	Using a triangular bandage folded along its base, form a clove hitch about one-third along the length of the bandage.
4	Slide the clove hitch over the hand to the wrist so that the shorter end is in front and snug the knot down on to the wrist.
5	Take the long end of the bandage up over the injured side around the neck to the uninjured shoulder and tie the two ends together with a reef knot that should lie in the hollow above the collar bone on the uninjured side.
6	Check for tissue perfusion and the radial pulse and if there has been a reduction, readjust the sling to reduce the angle of the elbow.

Figure 162 Collar and cuff sling: Place the injured arm to point towards the opposite armpit

Figure 163 Collar and cuff sling – form a clove hitch

Figure 164 Collar and cuff sling: Slide clove hitch over injured wrist

Figure 165 Collar and cuff sling: Tie reef knot above collarbone on the uninjured side

Figure 166 Collar and cuff sling: Check the radial pulse

10.3 *Splints*

A splint is any item that assists in immobilising an injured part. A splint may

be:

- one of a number of types of man-made devices;
- any stiff material, with padding, which conforms to the required shape of the injured part; or
- an adjacent uninjured part of the body (e.g. a finger or leg).

The basic principles of successful application of a splint are:

1) appropriate selection;

2) preparation; and

3) application including adequate explanation to the casualty and bystanders.

As with slings, before and after application the pulse and tissue perfusion (or sensation where direct access is not possible) in the affected extremity should be checked and if there is any change the splint should be adjusted to ensure that it is not compromising circulation in the injured limb. If the pulse cannot be directly felt, check that sensation has not been impaired by asking the casualty.

The application of splints in common use within the Ski Patrol context is described in detail below. The simpler splints may be used in a variety of methods, and not all are illustrated here. All splints must be used with the above basic principles in mind, to stabilise and protect the casualty's injury while transporting for further treatment.

10.3.1 THE AIR SPLINT

An air splint is a double-walled tube equipped with a zipper.

Uses:

- as a temporary splint for fractures;
- in burns to help to reduce plasma loss;

- to help retain dressings;
- to aid in reduction of swelling and bruising with soft tissue injuries; or
- as a cushion or support.

An air splint should not be used to splint a limb that cannot be straightened at its central joint. Do not use for injured joints, other than as a support or cushion for the injured limb.

Application – Lower Leg Injury:

Step	
1	Ensure the splint is in full working order and ready for use (laces, zips, inflation tubes, etc in place) before presenting it to the casualty.
2	Check the circulation and sensation in the foot. If unable to check directly, ask the casualty if they can move and feel their toes.
3	Support the ankle and lower leg with an outstretched arm.
4	Support the fracture and gently lift the limb, ensuring that support is maintained throughout. *Steps 3 and 4 may also be achieved by placing one hand through the heel of the splint so that support can be maintained until the splint is almost fully inflated. The other hand may be used to directly, or by grasping the fabric of the casualty's clothing, support the fracture and gently lift the limb.*
5	Have an assistant pull the loose splint up under the limb, and fold it to length if necessary. Replace the limb onto the ground, maintaining support, and have the assistant fully zip up the splint.
6	Continue maintaining support and inflate the splint using a hand pump or by mouth, observing infection control protocols. Ensure that the splint inflates evenly around the limb and that the ski boot is in the centre of its recess. The splint must support both the sole and upper parts of the boot, and should not twist the leg. Watch the casualty's face for any indication of pain as the splint is inflated. Gently remove your arm from inside the splint as it inflates. Support the leg with your other arm as you do so.
7	Ensure that the splint is inflated as much as possible, without increasing pain, or making the casualty uncomfortable.
8	Check that pulses are still present in the limb at the far end of the splint, and ensure that the bung is firmly in place to seal the air opening and prevent loss of pressure during transport.
9	Elevate the limb. Check the pressure in the splint every few minutes to make sure that there is no air leakage. *Be wary of change of air temperature which has a significant effect on the splint pressure; e.g. if the splint is put on inside and the casualty is transported outside in the cold. Significant changes in altitude, for example on a long ski run or in helicopter evacuations, may also reduce the effectiveness of the splint.*

In cases of an open wound or compound fracture, the splint should be applied over an appropriate sterile dressing.

Figure 167 Lower leg Air splint: Check the splint is complete and in working order

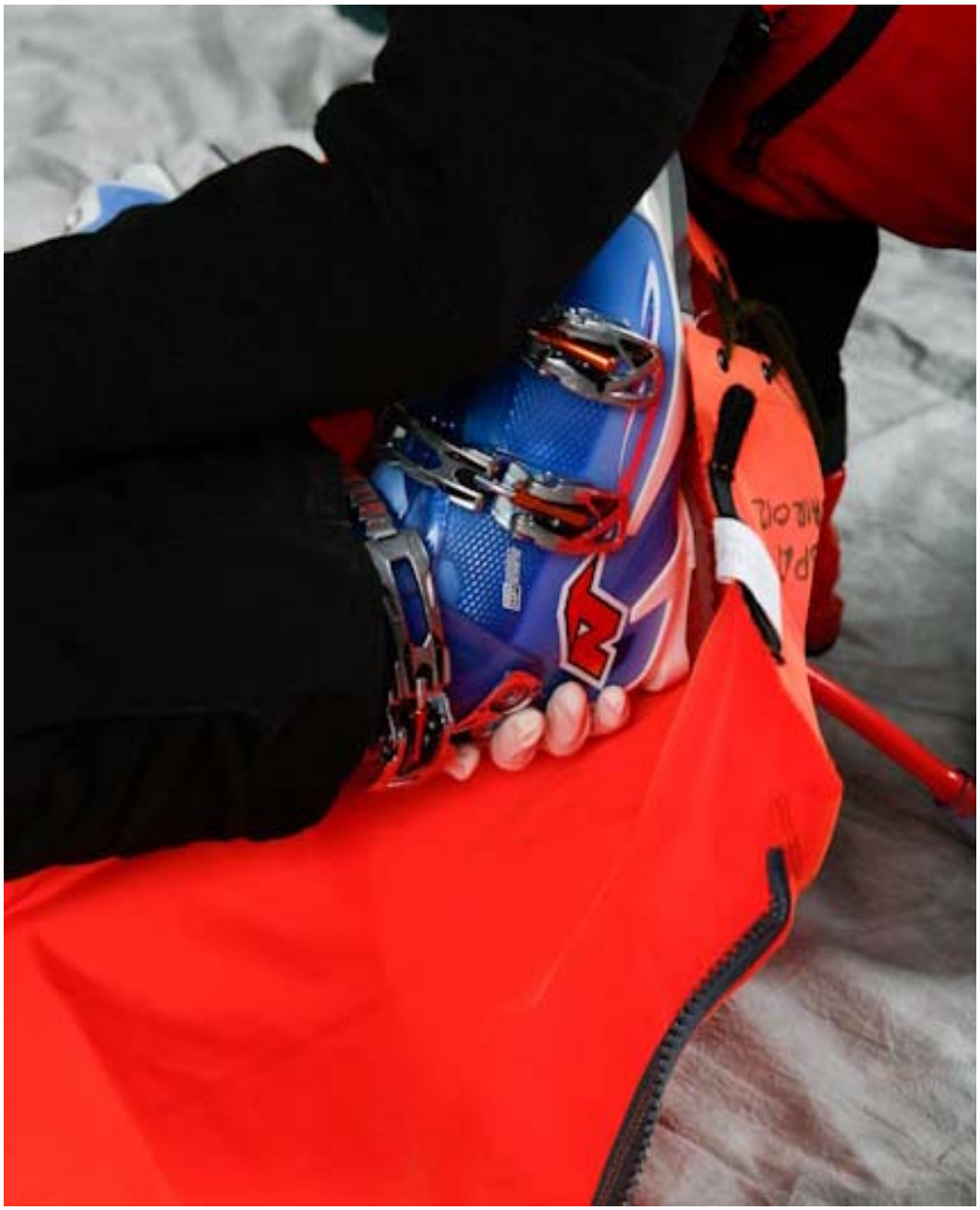

Figure 168 Lower leg Air splint: Place hand through heel of splint and grip the boot

Figure 169 Lower leg Air splint: Support the leg and lift gently

Figure 170 Lower leg Air splint: Assistant pulls splint up and zips splint

Figure 171 Lower leg Air splint: Inflate splint, checking fit and evenness of inflation

Figure 172 Lower leg Air splint: Elevate the limb

Application – Shoulder Injury:

The Air Splint may be used in a number of ways to support an injured limb in a position of comfort, where the casualty requires a cushion or large pad between their injured limb and another part of their body or a surface.

One example is the use of the air splint as a cushion between a casualty's arm and body when a shoulder injury prevents the arm from being comfortably swathed to the body directly.

Step	
1	Ensure the splint is in full working order and ready for use (laces, zips, inflation tubes, etc in place) before presenting it to the casualty.
2	Check the circulation and sensation in the fingers.
3	Prepare the air splint by folding inside itself to create a half-length splint, insert two or more triangular bandages through the air splint, and position the inflation hose and one-way valve.
4	Support the injured limb and gently insert the air splint between the injured limb and the body, with the splint high up under the armpit and centred on the upper arm. Secure the splint by tying off the triangular bandages: one from the armpit over the uninjured side clavicle, and the other around the chest.
5	Gently inflate the air splint, reassuring the casualty and watching their face for signs of discomfort. The splint will provide support and some lift to the injured limb, and may need to be re-positioned slightly for comfort. Seal the air opening.
6	Once the casualty's injured limb is comfortably supported, swathe the injured limb to the casualty firmly. It may be necessary to pin the swathe to the casualty's clothes to keep the swathe in position across the angled limb.
7	Check that a pulse is still present in the limb at the far end of the splint, and ensure that the bung is firmly in place to seal the air opening and prevent loss of pressure during transport.
8	Elevate the limb with the casualty in the position of most comfort. Check the pressure in the splint every few minutes to make sure that there is no air leakage. *Be wary of change of air temperature which has a significant effect on the splint pressure; e.g. if the splint is put on inside and the casualty is transported outside in the cold. Significant changes in altitude, for example on a long ski run or in helicopter evacuations, may also reduce the effectiveness of the splint.*

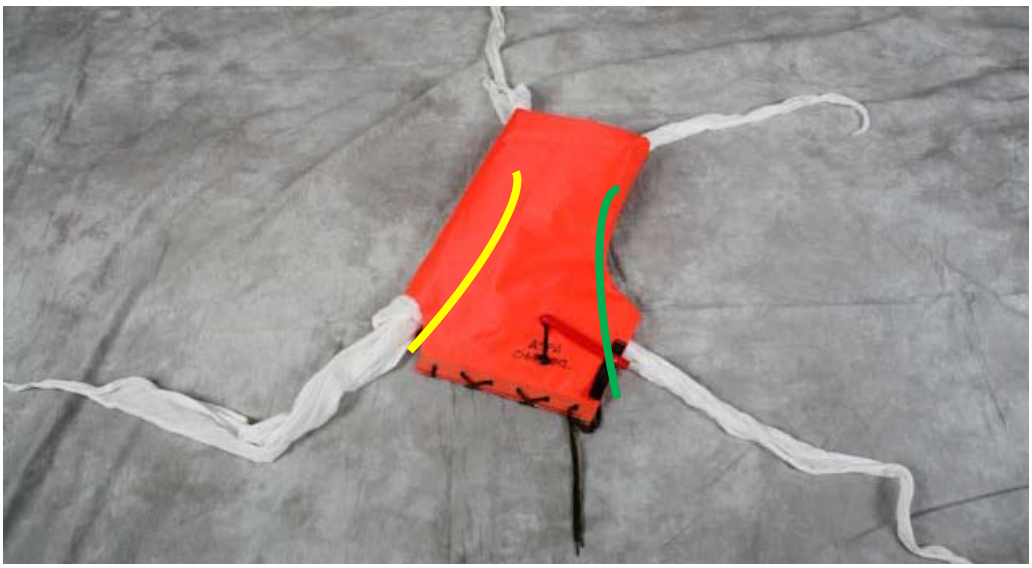

Figure 173 Shoulder Injury Air splint: Prepare the splint as a support for injured arm

Figure 174 Shoulder Injury Air splint: Position and secure the splint underneath the injured arm

Figure 175 Shoulder Injury Air splint: Inflate the splint to provide comfortable support for the injured arm

Figure 176 Shoulder Injury Air splint: Swathe the arm to the body and check circulation

10.3.2 THE ANGLE SPLINT

Uses:

The angle splint is a hinged plywood splint with foam backing and with a leaf that adjusts via a sliding arm and wing nut so that the angle achievable ranges from 180 degrees to about 300 degrees.

This splint was developed so that the arm could be supported at an angle away from the body (as is often found with a casualty who has a dislocated shoulder with the arm locked in a position away from the body). It can also be used to support a bent knee.

The angle splint is effective when applied correctly but it is notoriously difficult to attach to the trunk because it tends to slide down the body.

When straight, this splint can be used as a conventional board splint.

Application – Shoulder Injury:

Step	
1	Check circulation and tissue perfusion in the limb extremity before moving the limb.
2	Adjust the angle of the splint to fit under the casualty's armpit so that the long leaf lies against the chest wall down to the waist and the short leaf supports both the upper arm and the forearm. This often means that the elbow overhangs the short leaf of the splint. Insert at least three (3) triangular bandages into the splint for fixing to the casualty.
3	Have an assistant hold the splint in position whilst folded triangular bandages are attached around the upper and lower ends of the long leaf and the chest wall firmly. Attach a third bandage in the angle of the splint and around the neck, tying the ends together above the uninjured shoulder to prevent the splint sliding down the chest wall.

Figure 177 Angle splint: adjust angle of the splint with long leaf against trunk

Figure 178 Angle splint: Attach splint using triangular bandages to keep in place

4 Firmly bandage the upper arm and the forearm to the short leaf of the splint. This must be done in such a manner as to prevent rotation of the upper arm.

5 Compare circulation and tissue perfusion after application of the splint and adjust the splint if there has been any change.

6 When the casualty is positioned in the rescue sled, place blankets, jackets, etc around the injured arm to more effectively control movement of the injured part.

Figure 179 Angle splint: Bandage upper arm and forearm to short leaf of splint

10.3.3 THE BOX SPLINT

This splint is also known as the Sun Valley Splint. It is made of two boards connected along the bottom edge by canvas. Foam rubber padding lines the insides of the boards. The top edges are notched and it has cords attached for lacing the two top edges together. This splint is simple to use and apply.

Uses:

The box splint is suitable for use in all leg injuries below the femur, i.e. for suspected sprains, strains or fractures of the knee, tibia, fibula, and ankle. Its advantage over the air splint is in its use in knee injuries. An air splint can only be applied to a straight leg whereas a box splint can be just as effectively applied to a leg when the knee is bent or straight. With many ligament or cartilage injuries in the knee it is too painful or simply impossible to straighten the knee.

Obviously it cannot be transported as easily as an air splint and must be taken to an incident site independently or as part of the equipment kept stored in the Rescue sled.

Application:

Step	
1	Open the splint so that it lies flat, and untangle the tie-cord ready for use.
2	Check circulation and sensation in the limb below the injury site. If unable to check directly, ask the casualty if they can move and feel their toes

3 Support the injured leg and lift it slightly so that the splint can be slid under the leg, ensuring that the boot is enclosed in the lower end

4 Close the splint around the leg and hold it firmly together. Lash the splint together with the cord and knot, or tighten straps, to prevent it loosening

5 Elevate the limb by lifting under the splint

6 Re-check the circulation and tissue perfusion and adjust the splint if there has been any change

Figure 180 Box splint: Open splint and lay flat (note that the casualty's leg will often be bent as in the following figures)

Figure 181 Box splint: Support injured leg and slide splint underneath

Figure 182 Box splint: Close splint and lash together

Figure 183 Box splint: Elevate the leg

10.3.4 THE SAM™ SPLINT

Uses:

The SAM™ splint is a versatile splint constructed from a thin sheet of aluminium. It is 100mm wide, coated on each side with a layer of dense foam padding, and about 1m in overall length. The aluminium sheet may be bent into a curved profile, so that the splint becomes relatively rigid in its length when curved across its width. The splint can be formed into any required shape, limited only by its size and the strength required to support a particular injury.

Multiple splints may be combined, or one splint doubled over on itself, to give additional strength where needed.

The SAM™ splint is very lightweight and portable, being able to be rolled or folded to fit into a pocket. It can be used for support and immobilisation of limb injuries; it is not able to provide traction.

Application:

Step	
1	Check the circulation and tissue perfusion in the extremity of the injured limb before applying the splint.
2	Determine the size and shape of the injury to be supported and fold the splint to this configuration to check that it will be able to provide effective splinting.
3	Form the splint into a curved profile, shaped to suit the limb being supported, and bent at angles where necessary. Check that all sections are rigid enough to provide the level of support needed.
4	Place the splint at the injury site and strap the splint to the limb using triangular bandages. Supplement the splint with slings and swathes as required.
5	Re-check circulation and tissue perfusion at the extremities and adjust the splint if necessary.

Figure 184 SAM™ splint: Example of configuration and use

Figure 185 SAM™ splint: Example of use for support of injured forearm

10.3.5 STIFF NECK CERVICAL COLLAR

Uses:

A cervical collar is indicated where a casualty complains of neck and/or back pain after being involved in a traumatic incident, or when the mechanism of the trauma includes the potential for spinal injury.

Aim:

The aim is to minimise cervical spine movement in suspected or actual spinal injury.

Note: The cervical collar by itself does not provide complete cervical spine immobilization and must be used in conjunction with a spine board, head blocks, head tape and straps.

Application:

Application of the cervical collar requires at least two patrollers, one (A) to maintain inline head and neck support and the second (B) to measure and apply the collar.

Most collars used in a Ski Patrol context are of an adjustable type. The method of adjustment varies between types. Two commonly used collar types are illustrated here. The patroller must be familiar with the method of adjustment before using each type of collar.

Step	
1	Patroller A assumes a stable position behind the casualty's head, placing the palms of both hands on each ear with the fingers extended down the neck towards the shoulders, the index fingers are positioned under the jaw line to assist in maintaining a clear airway if necessary

Figure 186 Assume a stable position to support the head

2 If the head and neck are not in a normal anatomical position, inform the casualty that you are going to move their head and neck and they are to advise you if there is an onset or increase of pain and/or if other symptoms occur.

Gently move the head back to, and hold in the anatomical position, maintaining support at all times.

3 Patroller B removes any of the casualty's clothing/neckwear that may interfere with the application of the cervical collar. To determine the correct collar size, the fingers are used to measure from the top of the shoulder (trapezius) where the collar will rest, to the bottom plane of the casualty's chin.

Figure 187 Determine the correct collar size

3 Transfer the finger measurement from the neck to the collar. Select the appropriate size of collar.

Alternatively adjust an adjustable collar to the correct finger measurement. Typically adjustable collars have sizes of "no-neck" (1 finger), "short" (2 fingers), "regular" (3 fingers) and "tall" (4 fingers).

4 To simplify the application, flex the collar sharply inwards until you can touch the thumb to the fingers.

5 Kneel beside the casualty. Cradle the chin piece in your hand and gently slide the back portion of the collar partially under the base of the neck.

Figure 188 Gently slide the back portion partially under the base of the neck

6 Rotate the chin piece under the chin, making sure the casualty's chin covers the central fastener in the chin piece.

7 Whilst still cradling the chin piece, use the other hand, to gently pull the back portion of the collar through from behind the casualty's neck until firm and secure the Velcro without moving the head or neck.

Figure 189 Pull the back portion through while cradling the chin piece

Figure 190 Position under chin and against chest comfortably, fasten Velcro strap

10.3.5.1 ADJUSTABLE COLLARS

This two series of photographs shows the use of the commonly used adjustable collars: the Laerdal STIFNECK Select Adjustable collar, and the Ferno WizLoc Adjustable Collar.

Neither should be used on paediatric casualties, and they may be unsuitable for no-neck casualties.

Figure 191 Laerdal STIFNECK: Locate and adjust the right side size adjustment panel

Figure 192 Laerdal STIFNECK: Locate and adjust the left side size adjustment panel

Figure 193 Ferno WizLoc: Locate and adjust the front size adjustment panel

Figure 194 Ferno WizLoc: Locate and adjust the rear size adjustment panel

Figure 195 Ferno WizLoc: The front locking tab may be finely adjusted for comfort after the cervical collar is in position

10.3.6 THE SCOOP STRETCHER

The scoop stretcher is an aluminium, fibreglass, or plastic stretcher that can be 'broken' into two halves. Each half can then be placed ('scooped') under a casualty and reconnected so that the casualty can be lifted onto a support for transport with the minimum of movement and in the position originally found.

The Scoop stretcher alone is not a device for transporting the casualty any distance. It should be used to lift the casualty into an Akja or similar transporting stretcher.

Uses:

The scoop is ideal for use in:

- casualties with suspected spinal injuries (including all unconscious casualties);
- casualties with pelvic fractures or hip injuries where lifting may be very painful;
- casualties who have fluctuating levels of consciousness and who may need to be turned rapidly onto the side to protect the airway, preventing inhalation of vomitus;
- casualties who are suffering multiple injuries; or
- casualties suffering a fractured femur who are not able to be treated with a traction splint, or where lifting may be painful without the scoop stretcher.

Application:

Step	
1	Before the casualty is placed onto the scoop stretcher, the head and neck need to be stabilised in an appropriate brace or collar.
2	If appropriate, tie the arms and feet together with snug fitting triangular bandages.
3	Adjust the scoop to length by pressing the studs on the lower parts of the sides and elongating or shortening the arms. The scoop can only be elongated to a certain length before it will no longer fit into a rescue sled.
4	Break the stretcher by pressing the studs at top and bottom ends and pulling the two halves apart.
5	The patroller at the head of the casualty directs the assistants as the stretcher is placed so that the head supports line up with the casualty's head. The scoop stretcher is then reconnected at the head end. Make sure that snow does not prevent a proper reconnection. It may be necessary or of benefit to scoop a trench in the snow to prevent the clip filling with snow or ice.
6	Gently lever the bottom ends of the stretcher together. Take care to ease the body support leaves under the casualty so that there is no casualty movement. Tension clothing so that it does not catch in the leaves of the stretcher. Again, ensure that there is no snow or ice in the bottom connector that may prevent proper reconnection.
7	Prepare the casualty for transport by attaching firmly to the stretcher. This can be achieved by using webbing straps attached to the stretcher or by ties using triangular bandages. These should be placed about every twenty centimetres down the length of the body.
8	Tie bandages over the forehead or over the upper part of the skull, depending on the position in which the casualty has been placed on the scoop stretcher. This aids in head and neck stabilisation. If the casualty is lying on their back, a rolled blanket formed into a horseshoe around the head will also be of assistance.

The scoop stretcher is an ideal method for lifting a casualty with the minimal amount of movement. The casualty can be placed on the scoop in any position and should be so well secured that it is possible to flip the scoop upside down and still have no movement of the casualty. Be wary, however, of over-tightening strapping, particularly at the head.

Note that when transporting unconscious casualties, or casualties who are likely to become unconscious, it is preferable to place the casualty into the lateral position before scooping. In this case additional care will be needed in packaging and stablising to avoid movement of the head and neck.

This stretcher may be effectively used to transfer a casualty into a vacuum mattress for improved support during transport.

Figure 196 Scoop stretcher: Tie arms and feet together with the neck stabilised

Figure 197 Scoop stretcher: Adjust scoop to length

Figure 198 Scoop stretcher: 'Break' the stretcher and position the halves either side of the casualty

Figure 199 Scoop stretcher: Reconnect the head end first

Figure 200 Scoop stretcher: Gently lever the two halves together beneath the casualty

Figure 201 Scoop stretcher: Attach casualty firmly to the stretcher

Figure 202 Scoop stretcher: Stabilise the head using padding and straps

Figure 203 Scoop stretcher: Casualty secured to allow lateral position to clear airway

10.3.7 SPINE BOARD (SUPINE POSITION)

Indications:

The use of a spine board is indicated when a spinal injury is suspected. This occurs either when a casualty complains of pain in the neck and/or back following a traumatic event or when the mechanism of injury indicates possible spinal injury i.e.: a fall from greater than 2 metres.

Aim:

The aim of the spine board is to immobilize the thoracic and lumbar spine, providing full spinal immobilization when used in conjunction with a cervical collar, head blocks and strapping.

Application:

Step	
1	Inform and reassure the casualty. Fit the cervical collar. Place arms against the side of the body, palms facing in, or fold the arms across the chest. A figure-of-eight bandage can be tied around the ankles for ease when rolling.
2	Position the spine board alongside the casualty, on the opposite side to the patrollers, the top of the board being about 50cm above the casualty's head.
3	Prepare to log roll the casualty. Patroller A kneels at the head, Patroller B kneels at the mid-thorax and Patroller C kneels at the casualty's knees. When log rolling the casualty, Patroller A maintains support of the head and neck, keeping an anatomical alignment. Patroller B grasps the far side of the casualty at the shoulder and waist. Patroller C grasps the far side of the casualty at the hip and lower leg or ankles.

Figure 204 Support the head and body and roll the casualty

4 Patroller A is then in control of the roll, and the casualty is rolled towards the patrollers, at the time and pace called by Patroller A, ensuring minimal spinal movement. Slide the spine board along and against the casualty's back, either flat or slightly angled.

Figure 205 Slide the spine board along and against the casualty's back

5 Lower the casualty and the board to the ground together. Maintaining an anatomically neutral position, gently slide the casualty up the spine board to the correct position on the board (in as straight an axial movement as possible). Without moving the head, apply padding under the occiput (base of the skull) and lumbar spine to maintain correct positioning.

6 Secure the casualty to the spine board using the straps. Apply strap 1 from the shoulder, across the chest, to the opposite pelvic region, strap 2 across the other shoulder, as per strap 1. strap 3 across the pelvis and strap 4 across the upper legs above the knees. (Alternatively, strap 3 &4 can be crossed from pelvis to opposite knee area).

Figure 206 Attach straps

7 Strap 5 secures the ankles. Further strapping is used across the chest to secure the arms. Head supports (head blocks, towel rolls, etc) are positioned against the side of the head, from the shoulders, covering the ears.

8 Secure the casualty's head and the head support to the spine board by placing tape, in the following positions. (a) across the casualty's eyebrows and (b) across the cervical collar, ensuring that both pieces of tape are brought completely around the back of the spine board.

Figure 207 Complete by supporting the head and strapping firmly

10.3.8 THE VACUUM SPLINT

Use:

The vacuum splint has many uses. The splints come in a variety of shapes and sizes so the most appropriate shape must be selected for the area that is to be splinted.

The splints work on a vacuum principle (in reverse to that of the air splint). The splints are full of polystyrene balls similar to those used in beanbag chairs. There is a valve on the splint, and by using a suction pump air is evacuated from inside the splint. The vacuum thus formed pulls the foam balls tightly together, increasing the friction against one another and resulting in a rigid splint moulded to the casualty's injury.

To remove the splint the valve is held open, thus breaking the vacuum and removing the frictional forces, which kept the splint rigid.

The great advantage of this splint is that it is moulded to the area to be splinted before it is made rigid. This, coupled with the fact that there is a range of sizes extending up to a full body splint, means this is one of the most versatile of splints. It is especially applicable to a dislocated shoulder where the arm is often held in an awkward position.

The disadvantages include:

- The splint cannot exert pressure (as an air splint) or traction (as a Hare splint).
- It is less rigid than a normal rigid splint.
- It must specifically be called for, as it cannot be stored in a rescue sled.

Application:

Step	
1	From the range of splint sizes and shapes, select the one best suited to the part of the body requiring a splint
2	Even out the distribution of polystyrene balls in the splint, and using the pump provided, partially evacuate air from the splint to make it mouldable.
3	Check the circulation and tissue perfusion in the extremity of the injured limb before applying the splint. If unable to check directly, ask the casualty if they can move and feel their toes.
4	Support the limb (use an assistant) and mould the splint around the limb so that either the joints above and below the bone (for a fracture) or the bones above and below the joint (for a dislocation) are immobilised.
5	Completely evacuate the air from the splint and support further with triangular bandages where necessary.
6	Remove the pump from the valve and close the valve tightly. Re-check circulation and tissue perfusion and adjust the splint if necessary

Figure 208 Vacuum splint: Select the correct size

Figure 209 Vacuum splint: Even out the balls and partially evacuate the splint

Figure 210 Vacuum splint: Mould splint around the injured part

Figure 211 Vacuum splint: Evacuate air from the splint and support with bandages

Figure 212 Vacuum splint: Remove the pump

10.3.9 THE VACUUM MATTRESS

This series of photos demonstrates the order of operations. The principles of operation of the splint are the same as for other vacuum splints. The vacuum mattress is used to transport casualties who have been in a scoop stretcher in greater comfort than on the scoop stretcher itself. It is often used when extended transport is involved.

Figure 213 Vacuum Mattress: Prepare casualty for lifting by applying Scoop Stretcher

Figure 214 Vacuum Mattress: Prepare vacuum mattress next to casualty, even out the balls and partially evacuate the splint

Figure 215 Vacuum Mattress: Lift casualty and slide vacuum mattress underneath

Figure 216 Vacuum Mattress: Gently remove scoop stretcher

Figure 217 Vacuum Mattress: Mould splint around the casualty and secure straps

Figure 218 Vacuum Mattress: Evacuate air from the splint and support with bandages and straps, remove the pump

Figure 219 Vacuum Mattress: Casualty secured to allow lateral position to clear airway

10.3.10 THE KENDRICK EXTRACTION DEVICE (KED)

Use

The KED is mainly used for spinal injuries but can be used as a splint for other injuries, e.g. neck of femur, pelvis injuries. It can be washed with soap and water. Originally the KED was developed to extract people with spinal injuries from car seats. It is particularly useful for extracting casualties from tight situations. The instructions below are a

summary of the full Ferno™ training manual for this device. *Click on the Ferno symbol above to open that manual.*

The KED should only be used if casualty is less than 227kg. The KED itself weighs 3kg.

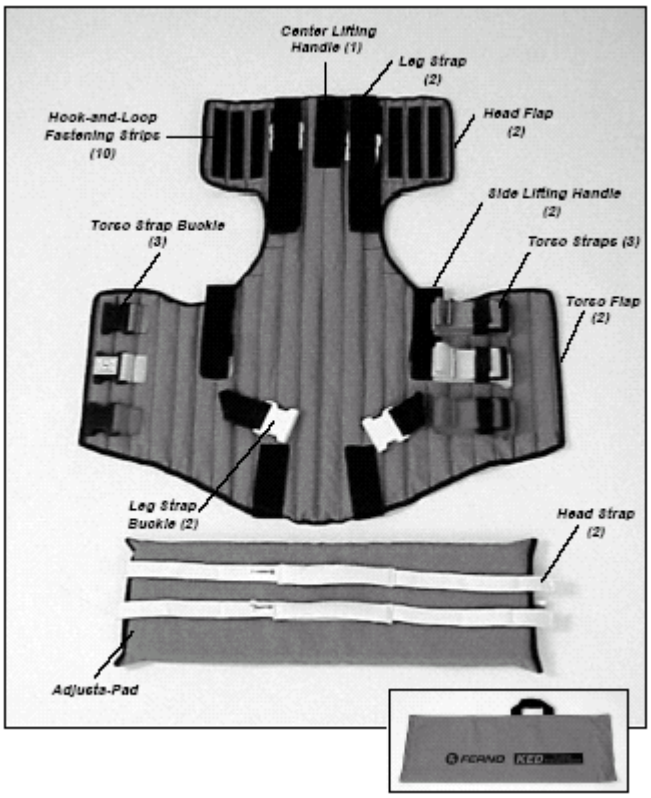

Figure 220 The Kendrick Extraction Device

Application:

Step	
1	Inform and reassure the casualty. Fit the cervical collar. A stiff neck cervical collar should always be used where possible.
2	Position the KED. The large flaps go to the bottom the smaller flaps to the top. The side of the splint with straps is faced away from casualty. If the head is to one side the wings may be folded under the splint, and the head stabilised in position found (making it not possible to use a collar).
3	The casualty should be left in the position found and the splint slid behind injured person (Remember the splinting rule, stabilise joint above and below the injury).
4	One patroller should at all times support the head while the splint is being inserted behind the casualty.
5	Slide the splint in at a 45^{o} angle to make use of the vertical rigidity of the splint when inserting it behind the casualty. Use the lift handles to centre the KED behind the casualty.

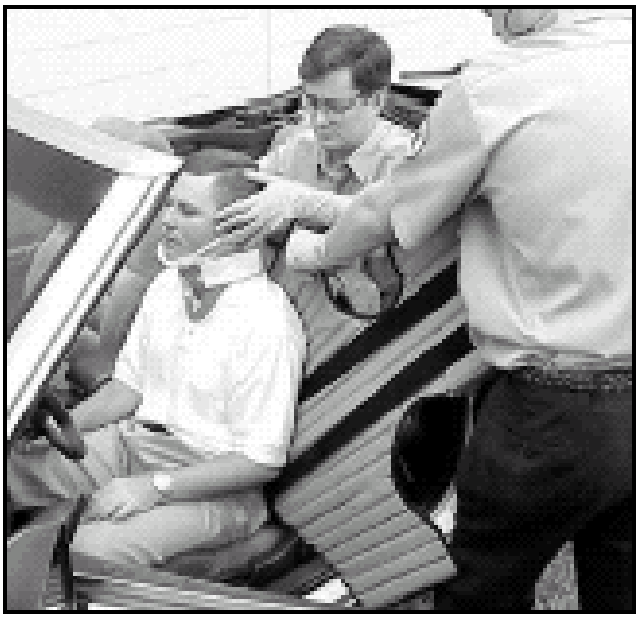

Figure 221 Support the head and slide the splint in at 45^{o} angle

6 Wrap both the torso straps around the casualty's torso, lifting the casualty's arms only as much as need to slide the flaps beneath them. The top of the flaps should be just below the casualty's armpits. This is important as it reduce the risk of the casualty slipping downward later when lifted.

Figure 222 Wrap the torso straps around the casualty's torso

7 Before beginning to fasten the straps, make sure the casualty is sitting back against the KED as fully as body structure and condition allow.

8 When wrapping the KED torso flaps around the casualty, fasten the middle (yellow) strap first, then the bottom (red) strap. Do not fasten the top (green) strap until just before you are ready to transfer the casualty to a long spine board.

9 When fastening the middle (yellow) strap initially, snugly tighten it until there is space for 2 or 3 fingers laid flat between the strap and the casualty's torso. You will tighten this strap just before transferring the casualty to the spine board. (The middle strap evenly secures the greatest possible area of the KED, providing the greatest casualty stability while you finish applying the KED).

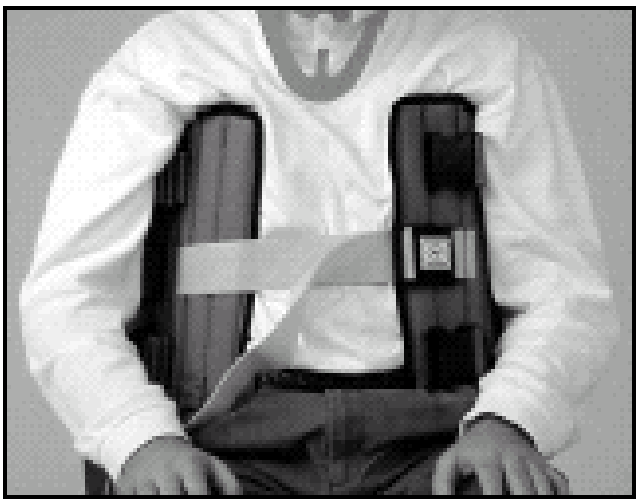

Figure 223 Middle (yellow) strap fastened

10 Now apply the bottom (red) strap and again tighten it initially as for the middle strap.

Do **not** fasten the top (green) strap at this time.

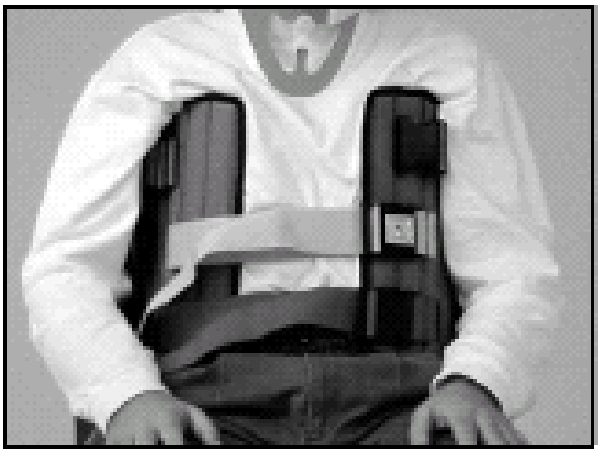

Figure 224 Middle (yellow) and bottom (red) strap fastened

11 The leg straps secure the pelvis to the lower portion of the KED to stabilise the lumbar area. Whether using either of the configurations for leg straps shown below, you must position the straps as close as possible to the casualty's body midline.

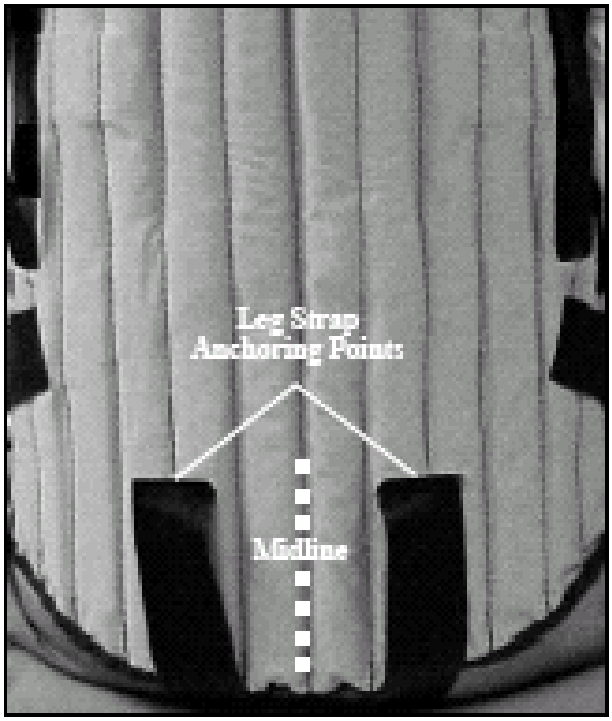

Figure 225 Back view of the leg straps when correctly positioned close to the body midline

12 Place leg straps under the legs and (most commonly) attach to opposite sides in 'criss-cross' configuration. (Buckle the left strap to the right buckle and the right strap to the left buckle). This configuration requires more care because the tendency during this application is to place the straps away from the midline.

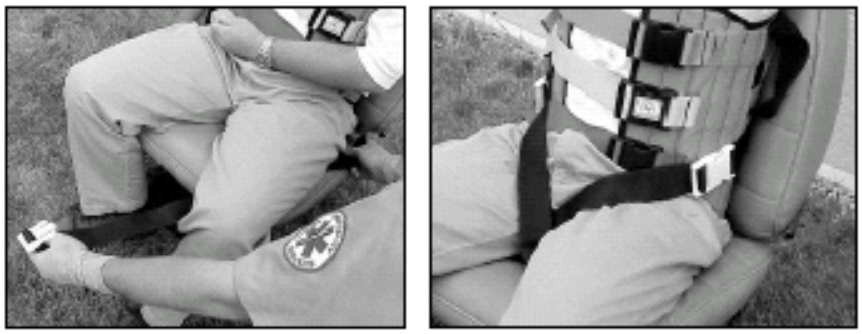

Figure 226 Leg straps applied in 'criss-cross' configuration

13 If a groin injury is suspected, you can use the straps in the 'same-side' configuration (buckle the left strap to the left buckle and right strap to the right buckle). This configuration requires more care because the tendency during this application is to place the straps away from the midline.

14 Wrap the head with top wings, padding any spaces. (Green foam filled adjustable padding is provided with the KED. It may be used single thickness or folded double.) Beware of hyperextending or flexing the casualty's neck when applying padding.

Figure 227 Positioning the adjustable pad

Figure 228 Wrapping the head flaps with padding in place

15 Check the splint is correctly position on the casualty.

16 Strap head in with restraints, or however possible, being careful not to obstruct the airway. The rubber strip in the centre of the head restraints can be turned inside out to distribute the pressure more evenly.

Figure 229 Head straps in place

17 When the spine board and rescue sled are prepared and waiting, buckle the top (green) strap and make final adjustments to the other straps, first the middle (yellow) strap and then the bottom (red) strap.

18 The KED should now be firmly in place from the lower spine to the head and positioned high up under the armpits to prevent movement during extrication.

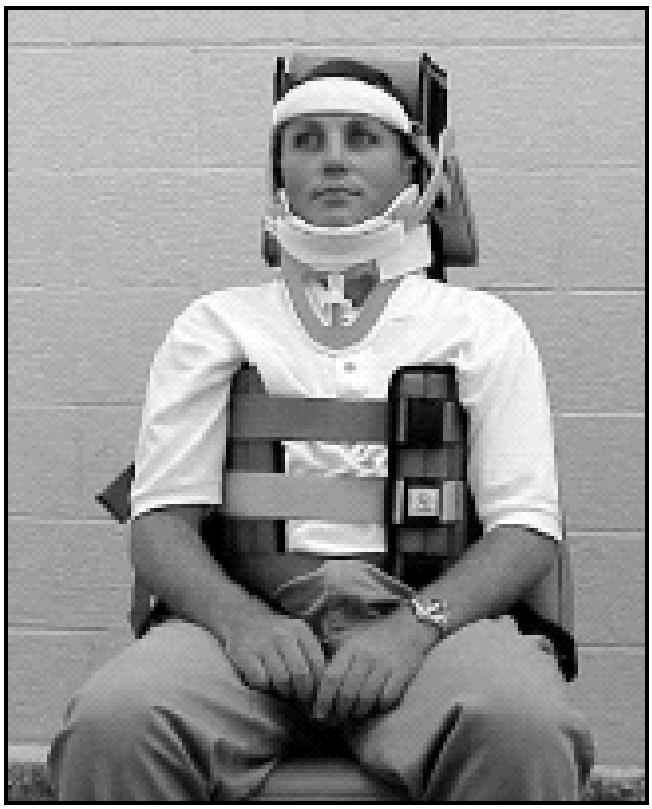

Figure 230 The KED, applied

Note:

- The KED IS NOT A LIFTING DEVICE. Three handles are provided to assist in manipulating the casualty and the KED onto the spine board.
- Slide the KED onto a backboard or similar (do not lift by the KED).
- When sliding KED and casualty onto board, hold splint by the hand holds supplied. Hold the casualty as well when sliding both onto the extraction board.
- Fasten the casualty onto the board.
- If there is a lowered level of consciousness place the casualty on their side on the board (i.e.: “A” before “F” in casualty approach protocol).
- Oxygen should be administered in most circumstances.
- Ensure that the straps are not so tight as to cause breathing difficulties.
- In incidents where defibrillation may be required, two slats of the two torso flaps on the KED may be folded inward before connecting the straps.

Full instructions from the makers of the KED are included on the ASPA CD. These include suggestions for dealing with pregnant casualties, paediatric cases, angulated neck and other special cases. Also included are Instructions for maintaining, cleaning and re-packing the KED after use.

10.3.11 THE HARE TRACTION SPLINT

Uses:

This is the recommended method for the first aid management of fractures of the shaft of the femur. It may not be appropriate to use it in fractures of the neck or head of the femur (i.e. a fractured hip). To differentiate between the two types of fracture is usually very simple as a fractured shaft of the femur causes pain that the casualty localises to the shaft. There is usually significant deformity of the shaft and often marked swelling at the damaged area. On the other hand, a casualty with a fractured hip is usually in less pain and localises that pain to the hip region. Both fractures tend to cause shortening of the damaged leg and both may be externally rotated. If there is doubt as to which fracture has occurred, you may still apply the Hare splint, but be cautious while applying traction.

Application of the Hare splint in a casualty with a fractured femur usually results in a marked reduction of pain, because traction tends to reduce the fracture and this minimises further blood loss. Both of these factors reduce the risk and severity of shock. The Hare splint may also be used in cases of lower leg injury, although simpler methods are usually appropriate.

Application:

In most cases, pain relief will be administered in conjunction with the application of the Hare Splint. Oxygen may need to be administered with pain relief where the casualty is in shock. Medical intervention may be required in cases of severe pain.

Proper application of the splint requires at least three patrollers (more if available), one of whom takes charge of the procedure and directs the other team members. All patrollers should practise the correct application of the splint until it becomes a routine procedure.

When traction is applied to the leg through the ankle hitch, counter-traction is applied by the padded half-ring against the ischial tuberosity of the casualty’s pelvis. Proper counter-traction is essential to the correct functioning of the splint.

Step

1. Place the splint beside the casualty's uninjured leg and adjust it to the length required. The padded half-ring should be at the ischial tuberosity and the splint extended 30 to 45 cm beyond the foot.

2. Open and adjust the four (4) Velcro straps to be above the fracture site, above the knee, below the knee; and above the ankle. Open the ischial strap and check the length of the strap is suited to the casualty's leg (adjust if necessary).

3. The patrollers then move to the injured side, taking care to walk around and never step over the casualty.

4. To prevent the casualty from sliding as traction is being applied, position an additional patroller or a bystander to support the upper body.

5. Check the circulation and tissue perfusion or sensation below the injury site. If unable to check directly, ask the casualty if they can move and feel their toes.

6. Whilst an assistant patroller holds and supports the injured leg to prevent rotation and other movement, the patroller in charge applies the ankle strap around the ski boot and connects the loops of the ankle strap to the end of the splint.

7. The patroller in charge applies traction, firstly along the line of the upper leg. This initial traction may have to be applied by grasping at the knee. The lower leg is then lifted up so that it also follows the line of the thigh. Traction can then be transferred to the ankle or the ankle strap. Care must be taken not to lessen the traction whilst the hand position is being changed. At the same time, the thigh is supported with one hand, either at the knee or under the fracture to prevent sagging of the thigh through the fracture site.

   Once applied, traction must be maintained at the same force until the splint has been applied.

8. An assistant patroller slides the splint under the injured leg and applies the ischial strap

9. An assistant patroller transfers traction to the splint by tightening the ratchet by hand. The casualty can usually advise if there is too much or too little traction. Observe the casualty's verbal and facial response at all times when applying traction.

10. When proper traction has been applied, fasten the support straps so that the limb is securely held to the splint. The boot is tied to the foot of the splint with triangular or other bandages to prevent any possible rotation.

11. Check the casualty's circulation and tissue perfusion have not deteriorated in the injured leg.

12. Monitor the casualty for the onset of shock (due to likely blood loss within the thigh). Treat for shock if it becomes evident, and transport to medical centre.

The patroller in charge of the incident scene should always talk to the casualty, reassuring and explaining what is about to happen. The casualty must have confidence in the patrollers, especially when traction is applied to the leg, and should be asked to advise if at any time traction seems to be inadvertently released.

Figure 231 Hare splint: Adjust the splint to length along the uninjured leg

Figure 232 Hare splint: Adjust Velcro straps

Figure 233 Hare splint: Support casualty's upper body to prevent movement

Figure 234 Hare splint: support injured leg and apply ankle strap

Figure 235 Hare splint: Traction is applied and must be maintained thereafter

Figure 236 Hare splint: Slide splint under injured leg and apply ischial strap

Figure 237 Hare splint: Transfer traction to the splint using the ratchet

Figure 238 Hare splint: Tie boot to splint to prevent rotation

10.3.12 THE DONWAY SPLINT

Uses:

The Donway traction splint is an alternative to the Hare traction-splinting device, and was developed in the early 1980's in Australia. Like the Hare splint, it is recommended for the first aid management of fractures of the shaft of the femur and, as with the Hare, it can be used in management of fractures of the lower leg.

In most cases, pain relief will be administered in conjunction with the application of the Donway Splint. Oxygen may need to be administered in conjunction with pain relief where the casualty is in shock. Medical intervention may be required in cases of severe pain.

Application:

At least two patrollers (more if available) are needed for correct application of this splint. The splint works on a pneumatic system whereby air is pumped into side arms which force two rams out. These rams, when connected to an ischial ring (thigh collar) and a footplate, exert force in opposite directions so that the length of the splint increases and places traction on the leg. Manual traction is not required except in cases where the leg must be moved in order to apply the splint; as it may be difficult in practice to maintain manual traction, consideration to an alternate splint should be given in such situations.

Step	
1	Check the circulation and tissue perfusion in the extremity of the injured limb before applying the splint. If unable to check directly, ask the casualty if they can move and feel their toes.
2	. Ensure all the contents from the pack are removed including the thigh collar, support webbing, knee strap, and downhill ski boot extension strap (if required). Prepare the splint for use by positioning the support webbing and knee strap to the outside of the injury (to avoid working over the injury site). Rotate the foot plate upward, remove the pump from the mounting bracket, and unlock the trombone arm nuts.
3	Support the casualty from the rear, if practical. Remove any objects from the casualty's pockets, so that the thigh collar will be as comfortable as possible.
4	Position the thigh collar by opening outward the plastic collar connectors and gently rolling the collar between the buttock and upper leg, with the two lugs facing the foot. The clasp is then fastened over the top of the leg and adjusted to provide a loose fit.
5	Position the splint below the casualty's foot and slide up until the foot is resting against the footplate. Gently place the casualty's heel into the Velcro foot stirrup and secure the foot or boot by crossing the remaining Velcro strap over the top and around the rear of the footplate, engaging the slots provided. Rotate the splint as needed to align the foot.
6	Extend the trombone arms and connect each one to the thigh collar connectors. Rotate the trombone arms one quarter of a turn to lock onto the connectors.
7	Apply traction to the leg by inflating the splint arms using the pump. Pump with a smooth action allowing the splint to move firmly against the casualty's thigh. An aided body roll from side to side will help the thigh collar find position. Inflate the splint until the pressure gauge needle is within the green zone; do not inflate beyond the green area. Watch the casualty's face for signs or relief (or pain) during the application of traction.
8	Position the plastic support webbing under the fracture site and between the ankle and knee. Apply the webbing by sliding under the outside trombone arm and under the leg, gently pulling through until all the slack is taken up. Take the remaining webbing and pass it between the leg and the inner trombone. Return the webbing over the inner trombone; slide under the leg and with firm but gentle pressure fix the webbing to the metal stud. Repeat this for the lower strap.

9	Raise the splint foot stand to elevate the injury. Recheck the air pressure and adjust if necessary, then lock the trombone arm nuts. Release the air pressure in the splint by depressing the air valve, to prevent seal failure during evacuation.
10	Apply the knee support strap over the knee. Where required, add broad triangular bandages to give additional support and stabilise the leg during transport.
11	Re-check circulation and tissue perfusion at the extremities and adjust the splint if necessary.

Figure 239 Donway splint: Set up the splint

Figure 240 Donway splint: Apply the thigh collar

Figure 241 Donway splint: Attach the foot stirrup to the boot

Figure 242 Donway splint: Extend the trombone arms to connect the splint to the thigh collar

Figure 243 Donway splint: Apply traction using the pump

Figure 244 Donway splint: Position the webbing and fix in place

Figure 245 Donway splint: Raise the stand, apply the knee support strap

10.3.13 THE SAGER SPLINT

Uses:

The Sager traction splint is an alternative to the Hare and Donway traction-splinting devices, and has become popular with Ski Patrols due to its relative simplicity compared with the other two devices. Like the Hare and Donway splints, it is recommended for the

first aid management of fractures of the shaft of the femur and it can also be used in management of fractures of the lower leg.

In most cases, pain relief will be administered in conjunction with the application of the Sager Splint. Oxygen may need to be administered in conjunction with pain relief where the casualty is in shock. Medical intervention may be required in cases of severe pain.

Application:

At least two patrollers (more if available) are needed for correct application of this splint. The splint has a sprung shaft that is extended manually once the splint has been secured to the injured leg. An indicator shows the correct range of traction to apply. Manual traction is not required except in cases where the leg must be moved in order to apply the splint; the Sager splint is simpler to manage than the Hare and Donway splints in such situations.

Step	
1	Check the circulation and tissue perfusion in the extremity of the injured limb before applying the splint. If unable to check directly, ask the casualty if they can move and feel their toes.
2	Ensure all the contents from the pack are removed including the **splint,** support webbing, and downhill ski boot extension strap (if required). Prepare the splint for use by adjusting the top cross bar for left or right side positioning, extend the traction cable, extend the splint shaft just beyond the length of the injured limb, and attach the ski boot extension strap.
3	Support the casualty from the rear, if practical. Remove any objects from the casualty's pockets, so that the **cross bar strap** will be as comfortable as possible.
4	Position the cross bar between the casualty's legs with their assistance, in a comfortable position, and secure the cross bar in place with the strap (hand tight). Attach the traction cable and boot straps. Preferably place the leg support webbing underneath the leg ready to use in position to support the injured limb, before applying traction.
5	Apply traction and support to the injured limb and extend the shaft of the splint to maintain traction, checking the gauge for correct tension range, and also checking the casualty's comfort.
6	Position the support webbing above and below the fracture site and between the ankle and knee. Attach the webbing firmly around the injured limb.
7	Elevate the limb with support.
8	Re-check circulation and tissue perfusion at the extremities and adjust the splint if necessary.

Figure 246 Sager splint: Unpack the splint

Figure 247 Sager splint: Position the crossbar and strap, support the casualty from the rear, attach the bootstrap and cable

Figure 248 Sager splint: Position the support webbing

Figure 249 Sager splint: Apply traction manually and maintain using the splint

Figure 250 Sager splint: Apply the support webbing

Figure 251 Sager splint: Elevate the limb with support

10.3.14 FOLDING TRACTION DEVICES

Indications

Folding traction devices are easily transportable and light weight traction devices designed for treating a fractured femur. They are typically stored in easily carried pouches.

Two similar types are in common use:

- The FareTec CT-6 is stored in a pouch of 27cm x 8xm and weighs 500g.
- The Kendrick Traction Device (KTD) is stored in a pouch sized 25cm x 9cm and weights about 500g.

Aim

To assist in the immobilization of the femur whilst applying traction to reduce pain.

Application – FareTec CT-6:

Step	
1	Check the circulation and tissue perfusion in the extremity of the injured limb before applying the splint. If unable to check directly, ask the casualty if they can move and feel their toes.
2	Remove the CT-6 from the pouch, and connect all tubing sections. Straighten any straps that are tangled. Place the splint alongside the uninjured leg. Size the splint by removing the ischial cap and adding or subtracting tubing, so that the overall length extends from just above the hip crest to 20cm below the casualtys boot. Replace the ischial cap, noting the two different hole sizes to suit the tubing.

3	Place the splint alongside the injured leg. Apply the ischial strap, sliding the male buckle under the leg, and slide upward until positioned in the crotch area. Engage the buckle. Cinch the strap until the traction pole receptacle is positioned at the belt line or hip crest
4	Apply the ankle hitch, wrapping the large strap section around the casualtys boot. Tighten the foot strap to fit snugly below the casualtys boot.
5	Apply moderate tension by pulling the cord exiting the purchase block. Lift the cord up into the V-jam to hold tension.
6	Apply the Velcro straps around the leg, starting with the strap above the fracture, then above the knee, then below the knee, then above the ankle.
7	Apply tension until the casualty is comfortable. If there is insufficient length in the splint, the ischial strap must be shortened. Secure the cord in the V-jam, and secure the end under the 4th strap, above the ankle
8	Check the circulation and tissue perfusion in the extremity of the injured limb after applying the splint. If unable to check directly, ask the casualty if they can move and feel their toes.
9	Splint as required for transport. Long spine board, board splint, tying legs together or any other accepted method.

Figure 252 Folding Traction Device CT-6 splint: Unpack the splint

Figure 253 Folding Traction Device CT-6 splint: Size the splint alongside the uninjured leg

Figure 254 Folding Traction Device CT-6 splint: Re-fit the Ischial cap to tubing

Figure 255 Folding Traction Device CT-6 splint: Fit the Ischial strap

Figure 256 Folding Traction Device CT-6 splint: Apply the ankle hitch

Figure 257 Folding Traction Device CT-6 splint: Apply moderate tension

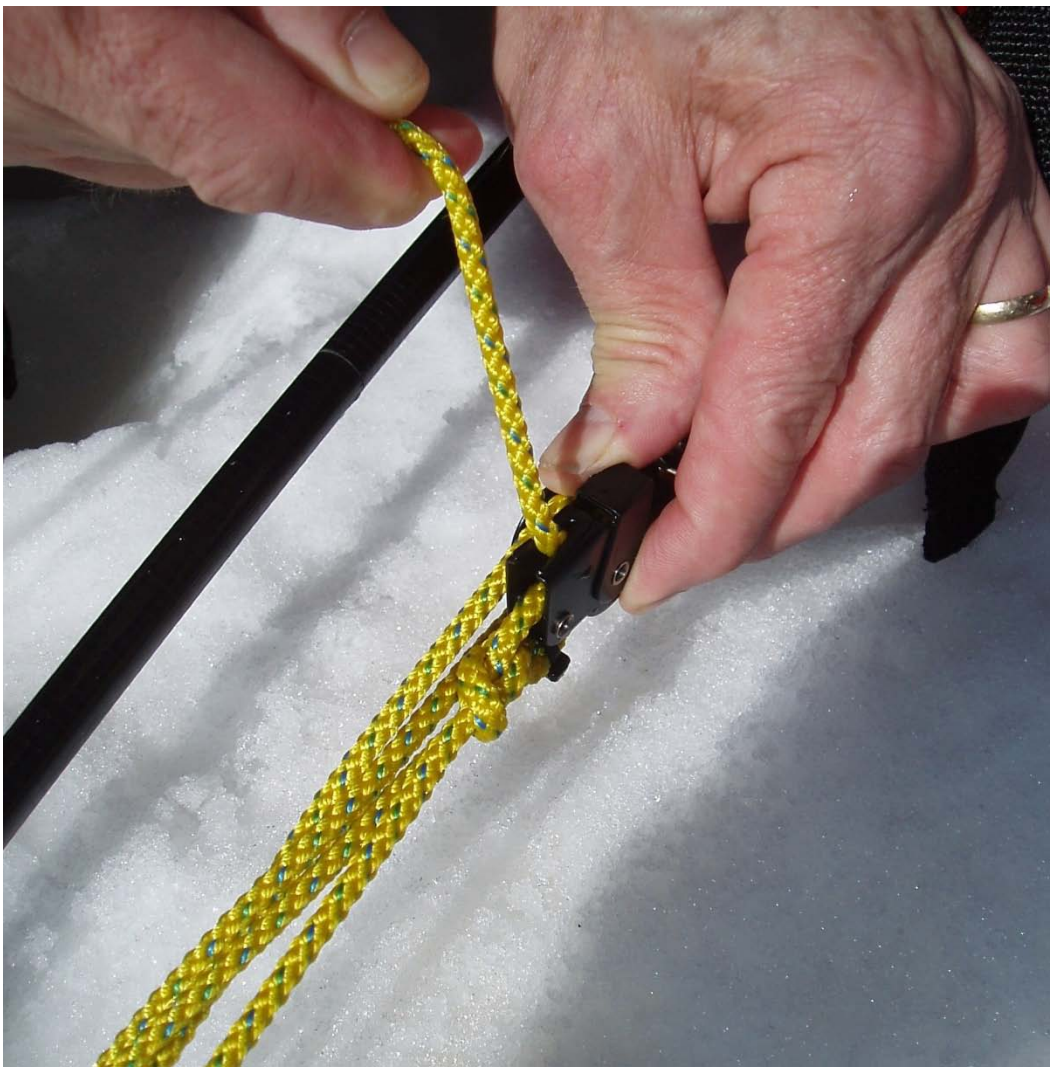

Figure 258 Folding Traction Device CT-6 splint: Use V-jam to secure cord

Figure 259 Folding Traction Device CT-6 splint: Apply Velcro straps

Figure 260 Folding Traction Device CT-6 splint: Apply tension to casualtys comfort and secure cord with V-jam and 4th strap at ankle

Application – Kendrick Traction Device:

Step	
1	Check the circulation and tissue perfusion in the extremity of the injured limb before applying the splint. If unable to check directly, ask the casualty if they can move and feel their toes.
2	Apply the ankle hitch tightly around the leg, slightly above the ankle bone. Tighten the stirrup by pulling the **green** tabbed strap under the heel
3	Apply the upper thigh system by sliding the male buckle under the leg, at the knee, and see-saw upward until positioned in the crotch area. Engage the buckle. A click signals that the buckle is locked. Cinch the strap until the traction pole receptacle is positioned at the belt line or pelvic crest. (Note: assure that male genitals are clear of the strap).
4	Snap out the traction pole. Make sure that each joint of the pole is securely seated.

5 Place the traction pole alongside the leg so that one section of tubing (20cm) extends beyond the bottom of the foot. Adjust the pole length as required, i.e. adult, paediatric, etc. Insert the pole end of ends into the traction pole receptacle.

6 Secure elastic strap around the knee.

7 Place the **yellow** tab over the dart end. Apply traction by pulling **red** tab. As a guide, apply approximately 10% of body weight to a maximum of 7kg tension. Casualty comfort will be your primary objective. Traction may be applied smoothly by grasping strap on each side of buckle and **simultaneously feeding and pulling** with equal pressure.

8 Check the circulation and tissue perfusion in the extremity of the injured limb after applying the splint. If unable to check directly, ask the casualty if they can move and feel their toes.

9 Finish packaging by applying upper (thigh) and lower (ankle) elastic straps. Splint as required. Long spine board, board splint, tying legs together or any other accepted method.

Figure 261 Kendrick Traction Device

10.3.15 THE THUMB / FINGER SPLINT

A thumb or finger splint may be any suitably sized rigid flat object. A tongue depressor is one typical choice.

Uses:

- as a splint to immobilise fractures, sprains or strains of the fingers or thumb.

Application – Skier's Thumb:

Step	
1	Check the circulation and sensation in the thumb and fingers.
2	Position the splint, together with padding if necessary for comfort or fit, and ask the casualty to hold in place.
3	Use a crepe bandage to attach the splint to the injured thumb. Wrap the thumb, hand, and wrist to immobilise the thumb effectively.
4	Secure the bandage by tying, pins, or a clip.
5	Check that circulation and sensation in the thumb and fingers remain.
6	Elevate the limb. The casualty may be more comfortable in an elevation sling.

Figure 262 Thumb Splint: Have the casualty hold the splint in position to begin bandaging

Figure 263 Thumb Splint: Wrap the thumb, hand, and wrist to effectively immobilize the thumb

Figure 264 Thumb Splint: Elevate the injured part

11 PAIN AND INHALATIONAL PAIN RELIEF

11.1 Introduction

Pain is defined as 'an unpleasant sensory and emotional experience associated with actual or potential bodily harm'.

Different individuals will interpret painful stimuli in terms of personal psychological makeup and there is therefore a wide spectrum of responses to pain. What one person may feel as a minor annoyance may cause another person major distress. Social, ethnic, personal, and physical factors all contribute to this variability.

An understanding of the factors responsible for the experience of pain allows the patroller to help minimise the discomfort of the injured casualty. Casualties will appreciate this above any other measure.

11.2 Mechanism of pain

The application of an injurious stimulus to part of the body causes a chemical reaction in specific sensory nerve endings that results in a sensation of pain. The painful sensation is then transmitted to the spinal cord via peripheral nerves.

At the spinal cord some fibres link up neurons which produce a withdrawal reflex that often occurs before the pain message reaches the brain. Other fibres travel up the spinal cord to the brain where the painful stimulus is interpreted and other psychological responses are elicited.

A specialised chemical mechanism within the brain and spinal cord allows the body to produce substances which decrease the sensation of pain (*endorphins*). This system is very active in times of high physical and mental stress. Many people will have experienced an injury during intense activity and only notice it later when relaxed. Among the host of chemicals produced are Endogenous Opiates (morphine-like substances).

11.3 Control of pain

Physical, chemical and psychological factors may be specifically targeted in the management of pain. Any agent or technique that reduces pain is known as an *analgesic*.

Control of pain through psychological factors is usually the simplest and most effective method. Reassurance of the casualty and an efficient, professional management of injuries go a long way toward decreasing discomfort. Many medical studies have proven a direct correlation between pain and anxiety. Thus, ***reassurance is always the first step in the management of any injury***. As part of reassurance, the patroller should attempt to have the casualty control and slow the rate of breathing.

Physical factors such as the splinting of fractures, dressing and bandaging of wounds and application of ice to soft tissue injuries are very helpful in decreasing the pain felt by the casualty, as well as minimising further injury.

Finally, the ever increasing understanding of the chemistry of pain allows specific pharmacological therapies at the various steps in interpretation of pain within the body. These may vary from simple analgesics such as aspirin and paracetamol through to extremely powerful and effective agents which are only used by medical specialists such as Anaesthetists.

In the general first aid and Ski Patrol environments the methods used are:

- reassurance and confidence;
- physical and mechanical means; and
- chemical and pharmacological agents, such as Penthrane and Entonox.

While reassurance and mechanical methods are part of the general management of the injured casualty, the decision on whether to use chemical means depends on the specific situation. As a general rule, if the casualty is experiencing undue discomfort, and consent is obtained for analgesia, it should be administered. A useful method of assessing a casualty's pain before offering pain relief, and which assists in identifying the reasons pain is present, is to use the mnemonic **PQRSTA**:

- **P** – What provokes or palliates the pain?

  What makes it better or worse?

- **Q** – What is the quality of the pain?

  Is the pain dull, aching, sharp?

- **R** – How does the pain radiate / refer?

  Where is the pain? Is it moving?

- **S** – Severity

  On their scale of 1 to 10, what level of pain is the casualty experiencing?

- **T** – Timing

  When did the pain start? Does it come and go?

- **A** – Associated Signs and Symptoms

  What are the associated signs and symptoms accompanying the pain?

Pain relief should not be offered to the casualty if it is not available. A pain relief agent must not be offered to a casualty for whom its use is contraindicated. All forms of chemical pain relief are contraindicated where the masking of pain is undesirable, or the level of consciousness is reduced, i.e.:

- head injury;
- drug or alcohol effects; or
- neck or spinal injury.

Specific contraindications for types of analgesia are detailed in the respective sections below.

11.4 *Penthrane (Methoxyfluorane)*

'Penthrane' is the commercial name for the volatile inhalational agent Methoxyfluorane. This substance was used as an anaesthetic agent in the 1960's and early 1970's and was noted to have good analgesic (pain relieving) actions. It has been superseded as an anaesthetic but remains very useful in the first aid setting.

Penthrane forms a vapour at ambient temperatures (i.e. it is volatile). This vapour is inhaled and the agent is absorbed by the lungs into the blood. The blood transports it to the brain, where Penthrane acts as an analgesic.

Over 95% is exhaled unchanged, the remainder being broken down by the liver. One of the breakdown products is the fluoride ion (F–). In very high levels this can impair the function of the kidneys, however sufficiently high levels are never approached in the first aid environment and consequently kidney conditions are not a contraindication to Penthrane.

The onset and offset of action is 2–3 minutes in each case. The 'Penthrane' Analgiser is a white or clear plastic inhaler that administers Penthrane only. 'Penthrox' is a green inhaler that is also used to administer Penthrane with the additional facility, via a plastic nipple, to directly administer oxygen therapy in conjunction with Penthrane.

Figure 265 Penthrox analgiser, ampoule, and felt insert

11.4.1 ADMINISTRATION OF PENTHRANE

- Obtain consent to use the drug from the casualty. In the case of minors, consent should be obtained where possible from a responsible adult carer.
- Reassure the casualty. Explain clearly the effects: taste, pain relief, dysphoria (altered mood), lightheadedness, and the time needed for the drug to work.
- Open an ampoule of Penthrane and pour its contents into the round end of the Analgiser. This will flow down into a felt-like sponge that acts as a reservoir whilst the liquid is vaporising. Up to two ampoules (6ml) may be used in a 24-hour period.

The second ampoule should only be used after the first one has been used up (approximately half an hour).

Figure 266 Open an ampoule and pour its contents into the Analgiser

- Give the Analgiser to the casualty and place the strap around the wrist. Direct the casualty to place the whistle-shaped end into the mouth, seal with the lips, and breathe slowly and deeply through the mouth. If possible, do not allow the casualty to breathe through the nose.

Figure 267 Casualty breaths in through the mouth and out through the nose

- Warn the casualty that it may take a few breaths to become accustomed to the odour.
- Tell the casualty to control the level of pain by removing the Analgiser when the pain is relieved but to return to it immediately the pain begins to reassert itself. Also indicate the diluter vent and encourage its use if pain is severe.
- On arrival at the medical centre, inform the staff that Penthrane has been used.

Penthrane must be self-administered by the casualty.

11.4.2 ADVANTAGES, DISADVANTAGES AND CONTRAINDICATIONS

ADVANTAGES

- Penthrane is highly portable, very effective, and free from adverse side effects when used as described above.
- Oxygen can be administered with Penthrane by the use of nasal cannulae or, preferably, by using a 'Penthrox' inhaler directly.

DISADVANTAGES

- Penthrane may be difficult to use in conjunction with some facial injuries.
- After use of the analgiser, it must be disposed of.

CONTRAINDICATIONS

- Exceeding total dose of 6ml in a 24 hour period. Casualties should be asked whether they have been treated with Penthrane within the last 24 hours before the subject of pain relief is raised as a possibility with them.
- In cases involving head or spinal injuries where analgesia in general is contra-indicated (it may cause interference with ongoing assessment of conscious state).
- In medical and longer term care of casualties, there are contraindications involving severe renal problems and preeclampsia in pregnant women. These are unlikely to

be found in the trauma situations which patrollers encounter and a limited dose (maximum 6mL) only is permitted.

11.5 Entonox

Entonox is an analgesic gas that contains 50% oxygen (O_2) and 50% nitrous oxide (N_2O). This gas is also odourless and not unpleasant in taste. The analgesic effect takes place within 1–2 minutes and lasts about 1 minute after removal of the gas. There is sometimes accompanying nausea and a feeling of euphoria is often induced. Some casualties feel drowsy once the pain has been relieved, but soon become alert again when the gas supply is stopped.

Administration of Entonox is via gas cylinders similar in size to those of oxygen (size C is the most efficient and portable). Entonox cylinders are painted blue and white and there is a specific pin system to only permit an Entonox regulator to fit on to the top of an Entonox gas cylinder.

Entonox is self-administered by the casualty through a demand valve that opens when the casualty inhales. The mouthpiece should be positioned so that if the casualty loses consciousness, the mask drops away from the face. Every casualty that uses Entonox also receives 50% oxygen.

Entonox cannot be used around sparks or flames because the oxygen supports combustion even though the nitrous oxide itself is non-flammable; refer to Section 5.6.3 **Hazards of Oxygen Supplementation**.

At temperatures below -7°C, the oxygen and nitrous oxide components of Entonox separate; consequently the Entonox cylinder must be stored in a warm place (above 10^0C). When in use on the snowfield, it must be laid on its side and well insulated from the cold; e.g. in a backpack inside foam padding. Inverting the cylinder three times before use can also prevent the separation of its components. Do not use if the Entonox cylinder's own temperature could be below -5°C.

Figure 268 Entonox gas cylinder, demand valve and mouthpiece

11.5.1 ADMINISTRATION OF ENTONOX

- Obtain consent to use the drug from the casualty. In the case of minors, consent should be obtained where possible from a responsible adult carer.
- Shake the cylinder, by inverting at least three times and turn on the gas supply after obtaining consent from the casualty to administer Entonox.
- Fit a clean disposable mouthpiece and one-way valve assembly to the flexible hose.
- Instruct the casualty to place the mouthpiece into the mouth, and suck on the mouthpiece.
- Encourage the casualty to breathe gently and slowly, without holding the breath. Warn the casualty that it may take some effort to initially open the inlet valve.
- Insist on self administration so that administration will cease if the casualty becomes unconscious. Ensure that the casualty holds the mouthpiece so that if the hand or arm relaxes it will naturally fall away from the mouth.
- Inform medical centre staff that Entonox has been used.

Figure 269 Entonox Self-Administration

11.5.2 ADVANTAGES, DISADVANTAGES AND CONTRAINDICATIONS

ADVANTAGES

- Entonox is an effective analgesic free from adverse side effects;
- 50% oxygen is delivered with Entonox; and
- equipment is reusable with the exception of low cost disposable mouthpieces and one-way valves.

DISADVANTAGES

- Entonox equipment is cumbersome and must be transported to the incident scene upon request.
- Entonox separates below -7^{0}C. The nitrous oxide is dispensed from the cylinder with little oxygen and the mix is hypoxic and potentially fatal. Do not use if the Entonox cylinder's own temperature could be below -5°C.

CONTRAINDICATIONS

- Head or spinal injuries;
- lowered level of consciousness; and
- chest injuries (due to the way in which the body handles the nitrous oxide, which will preferentially fill chest cavity spaces, potentially worsening any penetrating chest wounds).

11.6 Restricted Substances – Schedule 4 (S4)

11.6.1 STANDARD OPERATING PROCEDURE FOR "S4" DRUGS

Both nitrous oxide/oxygen (Entonox) and methoxyfluorane (Penthrane) are classed as Schedule 4 (Restricted Substances) "S4" drugs. The following details form the minimum requirements that must be adhered to for the management and use of all S4 drugs used in ski resorts.

Only a person in a position of authority within the resort hierarchy and who are authorised to carry and administer S4 drugs is considered suitable to purchase these drugs.

This person will hold responsibility for the security of all stock, the allocation and recording of any drugs from the secured cabinet, the recording of all use, and the return of all used and unused stock at the finish of the season.

Entonox and Penthrane must be kept in a secured cabinet in the First Aid facility, under a separate key that is kept by suitably qualified staff. Unauthorised staff will not be permitted any access to S4 drugs.

All S4 drugs must be regularly checked for expiry, volume, and signs of tampering, with the results recorded in a register. All usage must be recorded in the register as well as in the casualty records. Only a suitably approved form may be used for this register, which must be available for inspection at all times.

11.6.2 PREFERRED LOCATIONS FOR THE USE OF "S4" DRUGS

ASPA qualified ski patrollers normally carry and administer Penthrane on scene to casualties, who are then stabilised and transported to either the medical centre, first aid room or a location where handover to ambulance personnel is possible.

Entonox will be used in the first aid room or other location according to local protocols to manage only those casualties that require further pain relief beyond the limits of other drug and supportive methods, and where a delay is expected before ambulance handover can be effected.

While any pain relief is used, the vital signs of the casualty must be continuously monitored as described in section 3.3.2 **Vital Signs Survey** of this manual.

11.7 Conclusion

The vast majority of casualties encountered by patrollers will have painful injuries and may thus benefit from analgesia.

It is imperative the patroller is aware of this and acts accordingly, using all of the techniques described above.

Annual recertification for the use of analgesic gases is required and it is the responsibility of an appropriately qualified examiner within each resort to carry out this recertification.

12 INJURY DUE TO TEMPERATURE EXTREMES

12.1 Cold Injuries

12.1.1 INTRODUCTION

Under normal circumstances, the healthy body maintains a balance between heat production and heat loss.

In the cold the body attempts to maintain the internal or 'core temperature' by increasing heat production and decreasing heat loss.

Essentially all of the energy expended in the body is ultimately converted into heat, the only real exception being when muscular activity is used to perform some work outside the body. There are three main mechanisms of heat production:

- **Normal metabolism:** the body's metabolism produces heat by 'burning' energy within cells. About 95% of energy utilised in the body is derived from the reaction of oxygen with the various energy sources available to cells. The liver is a major source of heat production in the human body.
- **Muscular activity:** there is a significant increase in heat production when a resting muscle begins working. During periods of vigorous exercise, the body temperature may rise by a few degrees as a result of heat produced through muscular activity.
- **Shivering:** shivering is a form of involuntary muscular activity which increases heat production in an attempt to raise the body temperature. Shivering requires adequate energy stores and when these are depleted shivering ceases.

Wind speed (km/h)	Ambient Temperature (ºC)				
	5	**0**	**-10**	**-20**	**-30**
	Equivalent wind chill temperature (ºC)				
8	2	-5	-12	-24	***-34***
16	0	-9	-20	***-31***	***-45***
24	-4	-12	-23	***-40***	***-54***
32	-7	-15	-26	***-43***	***-60***
40	-9	-20	-29	***-45***	***-62***
			High danger		
				Extreme danger	

Table 9 Wind chill factor

Exposure to the cold can cause Hypothermia, Frostbite, and Frostnip. The extent of injury can vary from superficial skin damage to a profound, generalised body cooling and ultimately death. Cold injury is influenced by:

- the environmental temperature;
- wind speed;
- the body covering;
- the nutritional state of the body;
- the presence of water;

- fatigue;
- alcohol use; and
- diseased blood vessels.

12.1.2 LOSS OF BODY HEAT

Loss of body heat occurs by one or more of:

- **Radiation:** heat is radiated from the body to surrounding colder areas.
- **Conduction:** heat is conducted from the body through surrounding surfaces.
- **Convection:** heat from the body warms the air or water around it and this warmer area rises allowing it to be replaced by cooler air or water.
- **Evaporation:** the evaporation of perspiration or water requires heat which is drawn from the body.
- **Respiration:** inhaled air is warmed and humidified by the body, causing loss of heat. Increased respiration causes increased heat loss.

12.1.3 REACTION OF THE BODY TO COLD

The body's initial reaction to exposure to cold is to prevent further heat loss through *vasoconstriction*. By constricting peripheral blood vessels in the skin the flow of warm blood to the extremities is reduced, and the return of cool blood to the body's core is similarly reduced. The body selectively protects the vital organs by maintaining their blood supply and conserving heat for the core and sacrificing the periphery; e.g. the limbs. As a result, the temperature of the extremities falls and it is common to notice numbness and a loss of sensation to touch or pain. Muscles in the area become weak and peripheral nerve function is affected resulting in an impairment of coordinated movements.

The body's second response to cold exposure is to increase heat production by shivering which rapidly depletes energy stores if exposure to cold persists. When energy stores are exhausted, shivering stops. When this occurs, the body's heat production is greatly reduced. Even good insulation may not stop the net heat loss and the core temperature may fall rapidly. In such cases, active rewarming may be necessary.

As the core temperature drops, brain, lung, and heart function become impaired and eventually the casualty dies.

Exhaustion or any illness or injury will reduce a person's tolerance to cold, increase the likelihood of hypothermia and make death from hypothermia more likely.

12.1.4 SYSTEMIC HYPOTHERMIA

12.1.4.1 Definition and classification

When the body ***loses more heat than it can produce*** there is a reduction in the body temperature both superficially and internally.

Acute Hypothermia develops over a short period of time (less than 6 hours). The average person remains conscious for up to 1½ hours in water at 0°C. If untreated, death may occur within 1½ to 2 hours from the onset of the first symptoms of hypothermia if the casualty is not rewarmed.

Chronic Hypothermia develops over a longer period of time. The elderly are more at risk as a result of the aging process, medications, inadequate home heating, or some disease states. Subtle behaviour changes may be the only symptom.

12.1.4.2 Signs and symptoms of hypothermia

Initially the extremities become very cold, while the body attempts to maintain a normal core temperature. As the core temperature drops, the following signs and symptoms appear.

Core temperature (typical)	Signs and Symptoms
37 to 35 ^{o}C	Intense shivering with impaired ability to perform complex tasks.
Systemic hypothermia:	
35 to 33 ^{o}C	Violent shivering persists. Speech may be impaired. Impaired thought processes and amnesia develop. The casualty exhibits irrational and uncharacteristic behaviour.
32 to 30 ^{o}C	Decreased shivering is replaced by muscle rigidity. Coordination is affected producing erratic jerky movements. Poor comprehension and often total amnesia are evident. The casualty is usually able to maintain posture, but may become unconscious.
Deep hypothermia:	
29 to 27 ^{o}C	The casualty becomes irrational, and drifts into stupor. Muscle rigidity increases, pulse and respirations are slowed.
27 to 26 ^{o}C	Unconscious. Most reflexes cease to function. Heart beat becomes erratic.
< 26 ^{o}C	The casualty suffers cardiac fibrillation or asystole. Apparent death.

Table 10 Signs and symptoms of hypothermia

Note: the temperatures are indicative only and the temperature at which various signs and symptoms of hypothermia actually arise will vary, depending upon the rate of cooling, the health of the casualty and any underlying illness, injury or exhaustion.

Hypothermia offers the brain some protection from hypoxia. Oxygen consumption decreases by about 7% for each degree Celsius drop in the core temperature, so that at 30°C oxygen requirements are about 50% of normal. ***If a casualty is found very cold, unresponsive, and not breathing normally, attempts must be made to simultaneously resuscitate and rewarm the casualty.*** No casualty found hypothermic and pulseless should be considered dead until “warm and dead”.

12.1.4.3 Management of hypothermia

To prevent further heat loss:

- Provide shelter from the wind.
- Insulate the casualty from the ground or snow.
- Prevent evaporation from wet clothing by wrapping the casualty in a body sized plastic bag.
- Add as much extra insulation as possible in the form of rescue blankets or sleeping bag(s).
- Maximise insulation of the head with beanie(s), balaclava(s), blanket, etc.

- Severely affected casualties should always lie down and be handled gently to prevent shock which can precipitate cardiac arrest.
- Most heat loss can be prevented and a safe level of active warming provided if rescuers in their own clothing or sleeping bags snuggle up against both sides of the casualty. Rescuers can also use their bodies to keep the casualty off the snow if alternative insulation is inadequate.
- “Core rewarmers” deliver heated, humidified air or oxygen which prevents any heat loss from respiration. This can reduce stress on the casualty and increase the rewarming rate, particularly in very cold, dry conditions.
- If the casualty is conscious, administer hot, sweet drinks to replenish energy. Carbohydrate is the food most quickly transformed into heat.
- Handle gently as rough handling may precipitate cardiac arrythmias and can promote the flow of cold blood from the extremities to the core.
- Do not administer alcohol or drugs which may cause peripheral vasodilation and lead to a decrease in core temperature. Alcohol also inhibits the release of glucose from body stores.
- The decision as to whether to transport to medical care or bring medical care to the casualty must take into account the logistics of the situation and the state of the casualty. For example: A mild to moderately affected casualty, lack of insulating materials on site, a medical centre close by and the availability of rapid but gentle transport would favour evacuation. A severely affected casualty found by a search team far from other help should be stabilised on site with all necessary insulation and medical care brought to the incident site until it is clear that the casualty is stabilised and fit for transport.
- Rewarming is often a slow process. This is by no means a bad thing in most cases. Slow rewarming allows the body to adjust to the changes in temperature and metabolism that occur. The most important thing is to stabilise the situation by preventing any further cooling.
- If the casualty suffers cardiac arrest, CPR should be undertaken at normal rates and continued during emergency evacuation to the nearest facility where the casualty can be rapidly rewarmed. If rapid rewarming is needed, non-medical rescuers can attempt rewarming whilst continuing resuscitation by wrapping the casualty in a heating blanket or by immersing the casualty in a warm water bath (around 43°C). The preferable solution however, is to have medical personnel provide both external heating and invasive warming in an intensive care facility.
- Expect temperature after-drop. This occurs during rewarming when heat from the core is conducted to the cooler periphery, because the rewarmed brain causes peripheral blood vessel dilatation.
- Transport to medical care or bring medical care to the casualty.

12.1.5 LOCAL COLD INJURY

Frostbite and Frostnip occur in areas of localised hypothermia and are usually restricted to the extremities or exposed areas. The severity of the injury is influenced by temperature, moisture, wind, and duration of exposure.

12.1.5.1 Frostbite

Frostbite occurs when the capillary circulation ceases because of increased blood viscosity in the extremities due to the cold. If the temperature falls below freezing, the tissues then freeze and intra-cellular fluid crystallises. As ice forms, water is removed from the damaged cells which dehydrate and die.

Further exposure to cold continues this process so that larger and deeper areas become involved.

The damage caused by frostbite and burns is similar as is the healing process.

Frostbite is more prevalent:

- at altitude (for the same temperature, the effect is magnified compared to lower altitudes);
- in smokers;
- in those previously affected;
- if dehydrated;
- in an injured limb; and
- with tight clothing.

SIGNS AND SYMPTOMS

- the area affected becomes insensitive to cold or pain;
- the skin is cold, hard, and numb and will appear waxy white or mottled blue grey in colour; and
- rewarming produces intense pain and is followed by swelling, discolouration, blistering, immobility, and possibly gangrene.

MANAGEMENT

- Frostbite is difficult or impossible to treat outdoors and the casualty should be transported to medical care as soon as possible;
- do not thaw the affected area unless it can be guaranteed that protection from the cold is available afterwards;
- a casualty can walk on frozen feet without further damage, but walking on thawed feet will cause serious tissue damage and will be very painful;
- thawing of tissue requires adequate analgesia including narcotic injection;
- rewarming should take place in a container of water at 43°C, and must continue until the limb is red throughout; and
- broken skin should be protected by dressings, immobilised, and the casualty transported to medical care.

12.1.5.2 Frostnip

Frostnip is the early stage of frostbite, and if identified and treated early is easily reversed. Frostnip can occur without freezing of tissues but more commonly there is superficial freezing of the skin and surface tissues only. Typically the areas affected are the tip of the nose, earlobes, fingers, toes, and cheeks, most often due to a cold wind.

SIGNS AND SYMPTOMS

- With no freezing of tissues, there is no blood flow (perfusion) to the area, which may be swollen and will not function;
- with superficial freezing, a tingling sensation or sharp pain will occur, but may cease if the nerves become frozen; and
- the skin will appear blanched (white), firm and numb, and cold to touch, but still pliable.

MANAGEMENT

- Handle the casualty and especially the injured part gently;
- remove from cold and gently rewarm the area immediately, using body heat;
- do not rub the injured part or apply snow;
- after rewarming, the area may become numb, then swell and become warm and painful;

- if swelling and loss of function occur, rest and elevate the injured part, protect with dressings and transport to medical care; and
- blisters appearing after rewarming indicate that the freezing has been more than superficial and medical aid is required.

12.2 Heat injuries

12.2.1 BURNS

12.2.1.1 Definition

A burn is an injury to the skin and/or deeper tissues caused by contact with extremes of temperature, electricity, radiation, friction, gases, or chemicals. Burns may lead to loss of body fluids, hypovolaemic shock, and possible infection.

12.2.1.2 Classification

Burns are classified according to the depth of tissue damage.

- Partial Thickness (1st and 2nd degree) Burns.
  These may be very superficial with red skin and minor pain only (1st degree), or the skin may be blistered and very painful (2nd degree). Partial thickness burns are the most common types of burns and are painful as only the top layer of the skin has been removed, leaving the nerves and pain receptors fully functioning.
- Full Thickness (3rd degree) Burns.
  All the skin, including the pain receptors, is destroyed so there will be no pain at all though there may be areas of partial thickness burns surrounding it.

Often it is difficult to determine whether a burn is full or partial thickness for several days.

Significant burns need to be referred to medical care as soon as possible. Significant burns are:

- greater than 10% of the total body surface area of an adult;
- a full thickness (3rd degree) burn of greater than 5% of the total body surface area of an adult;
- those of special areas – face, hands, feet, genitalia, perineum, major joints, circumferential burns of limbs or chest;
- electrical or chemical burns;
- those associated with an inhalational injury;
- those in casualties with pre-existing medical disorders that could complicate management or recovery or increase mortality; or
- any burns in infants or children, or in the very old.

12.2.1.3 Estimating area

To estimate the size of any burn, use the palm of the casualty's hand. The area of the palm, excluding fingers, is equivalent to 1% of the body surface area. For larger areas, the 'Rule of Nines' may be applied:

Area	Adult/Child	Infant
Head and Neck	9%	18%
Upper limb	9% each, total 18%	9% each, total 18%
Lower limb	18% each, total 36%	14% each, total 28%
Trunk front	18%	18%
Trunk back	18%	13%
Other	Genitalia 1%	Buttocks 5%

Table 11 Estimating the area of a burn

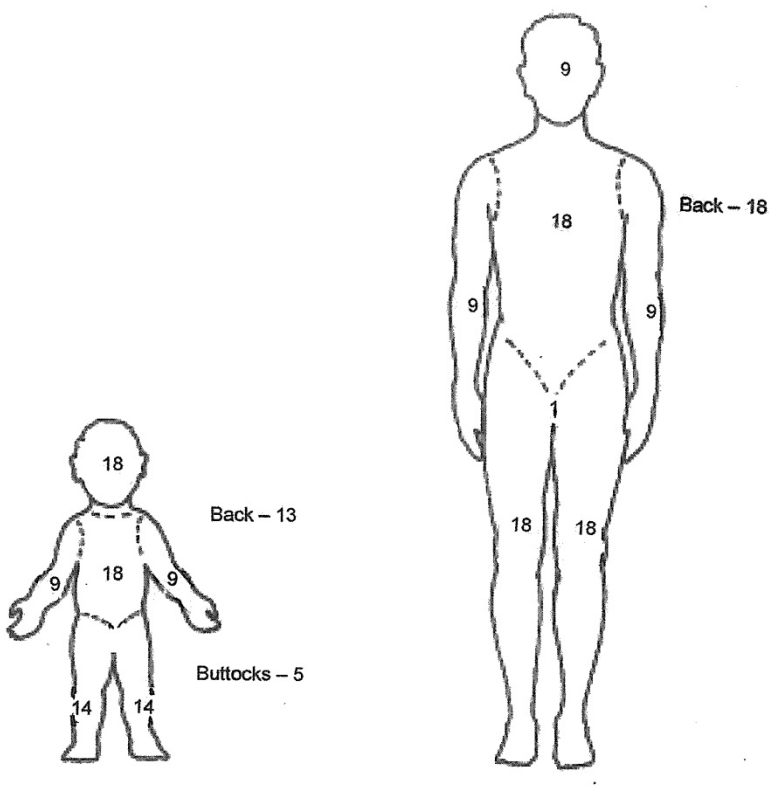

Figure 270 Rule of Nines for estimating the extent of burn injuries

12.2.1.4 Shock in burns

Hypovolaemic shock can occur in large burns, due to a fall in circulating blood volume secondary to the loss of plasma from the burned area.

12.2.1.5 General management

The aim of management is to relieve pain, prevent infection and maintain blood volume, through:

- removing the cause of the burn;
- early application of cold water which relieves pain, and can prevent the death of cells on the perimeter of the burn (continue application for at least 20 minutes);
- initiating basic life support if necessary;

- covering the burn with a sterile dressing to protect the very sensitive nerve endings from moving air;
- treating for shock as it occurs; and
- transporting to medical care.

Do not:

- remove charred or adhering clothing, metallic flakes, or burnt tissue from the burn;
- apply cotton wool or any material with loose fibres to a burn;
- apply lotions, creams, or ointment to burnt areas; or
- break blisters (unless in the throat or mouth and obstructing the airway).

12.2.1.6 Specific management

Generally:

- maintain the safety of yourself, bystanders, and the casualty. Be wary of burning or toxic atmospheres;
- stop the burning process – Stop, Drop, Cover and Roll if on fire, smother any flames with a blanket, and remove from the burn source;
- assess **DRS ABC**;
- check for other injuries;
- remove any rings, watches, jewellery or similar from the affected area without further injury; and
- elevate burnt limbs to minimise swelling where possible.

Minor burns

- run under clean cold fresh water for at least 20 minutes to reduce tissue damage and relieve pain;
- cover with a loose, light, sterile dressing (preferably dry and lint-free, for example plastic cling-film);
- continue cold, wet dressing applications to relieve pain (be careful not to cool children or frail adults so much that hypothermia occurs); and
- transport to medical care for assessment.

Electrical Burns

- beware of hidden dangers of live electrical components;
- beware of invisible subsurface damage;
- cool burns if it is safe to do so, as for minor burns;
- administer Oxygen if safe to do so; and
- transport to medical care for assessment.

Respiratory Burns

- suspect respiratory burns if the casualty is burned within an enclosed space
- always assume a respiratory burn if there are burns to the face, nose, mouth, eyebrows or eyelashes, or carbon deposits in the nose or mouth
- beware of and check (if possible or necessary) for blisters within the airway;
- administer Oxygen;
- do not assume the casualty is stable because they are breathing, talking, and mobile – some agents produce a delayed response; and

- transport urgently to medical care.

Sunburn

- transport to medical care if there are blisters present or if the casualty has a fever;
- do not break any blisters; and
- otherwise, give copious fluids (not alcohol) and analgesia, and cool locally burnt areas with water for up to 20 minutes

Chemical Burns

- refer to the Material Safety Data Sheet for the chemical (if known) for specific treatments;
- contact the Poisons Information Centre on 13 11 26 for advice;
- gently wash the chemical off the skin with large volumes of fresh, clean water (alkali burns require longer washing than acid burns, especially in the eye);
- remove contaminated clothing;
- run under clean cold fresh water for at least 20 minutes to reduce tissue damage and relieve pain; and
- if chemical burns affect the eye, flush thoroughly with fresh water for at least 20 minutes and refer to urgent medical attention.

Other specific Burns:

- *Phosphorus*: dress in saline soaked dressings to neutralize ignition on contact with air.
- *Hydrofluoric acid*: Flush with copious quantities of water and apply calcium gluconate gel if available (this gel is normally available where Hydrofluoric acid is in use).
- *Bitumen*: irrigate with cool water to cool the bitumen, do not attempt to remove from the casualty's skin.
- *Petroleum products chemical burns*: irrigate with copious water.

12.2.2 HYPERTHERMIA

12.2.2.1 Introduction

The body continually produces heat, which must be dissipated to prevent the core temperature rising. If excess heat is retained and the body core overheats, there will be damage to the central nervous system and kidneys. Death may occur in extreme cases.

Heat induced illnesses may be caused by:

- Heat absorption from a hot environment;
- Heat production from metabolic activity;
- Failure of the body's cooling mechanisms; or
- A change to the body's set temperature.

Factors that contribute to heat induced illnesses include:

- Physical exertion;
- Hot climate with high humidity;
- Inadequate fluid intake;
- Infection (especially viral);
- Adverse environments (for example an unventilated hot space);

- Inappropriate heavy dark clothing on hot days; and
- Drugs that affect the body's heat regulation mechanisms.

The very young and very old are at greater risk.

12.2.2.2 Heat cramps

Muscle cramps may occur as a result of depletion of chemical stores within the muscles from profound sweating.

MANAGEMENT

- Cease work or exercise and move to a cooler environment;
- massage the cramped muscles; and
- increase the fluid intake through supplementation with salt, electrolyte, or glucose based drinks until acclimatised.

12.2.2.3 Heat exhaustion

This common illness caused by heat results in a prostrated casualty because fluid lost through sweating and respiration has not been adequately replaced. Heat exhaustion can be accelerated by strenuous work or exercise, which increases blood flow to skin and muscles, drawing it away from the vital organs and the brain.

SIGNS AND SYMPTOMS

- Irrational and uncharacteristic behaviour;
- weakness;
- dizziness;
- nausea;
- loss of appetite;
- fainting;
- cool clammy skin;
- weak rapid pulse;
- rapid shallow respirations; and
- oral temperature may be normal or low, but core temperature will be slightly elevated (less than 40^{o}C).

MANAGEMENT

- Cease work or exercise and move to a cooler environment;
- remove extra clothing;
- rest the casualty;
- treat for hypovolaemic shock (give water only); and
- if prompt recovery does not occur, transfer to medical care.

12.2.2.4 Heat stroke

This most life-threatening form of heat exposure occurs as a result of the collapse of the body's cooling system and subsequent rise in body temperature. This failure in cooling is due mainly to cessation of sweating caused by heat damage in the central nervous system.

SIGNS AND SYMPTOMS

- Rapid onset once sweating ceases;
- hot, dry flushed skin (however in some casualties profuse sweating may occur);

- full, rapid pulse initially, decreasing progressively;
- deep respirations initially, progressively slowing;
- very high body temperature (over 40^{o}C); and
- progressing to unconsciousness, convulsions, and death.

MANAGEMENT

- move the casualty to a cool environment;
- actively cool the casualty using a wet sheet and fan, and ice blocks applied to the neck, groin, and armpits;
- monitor vital signs and manage any changes; and
- transport to medical care.

12.3 Snow glare or snow blindness

The sun's ultraviolet rays (UVA and UVB), both direct and reflected from the snow, can irritate eyes which are not protected by suitable UV screening glasses.

SIGNS AND SYMPTOMS

- A burning, gritty sensation in the eyes with intense pain, usually occurring a few hours after the exposure has occurred;
- redness and swelling of the eyes;
- sensitivity to light; and
- teary eyes.

MANAGEMENT

- Place the casualty in a dark room;
- pad both eyes initially, then wear sunglasses for 2–3 days after the symptoms have resolved;
- ice compresses give some relief, as does aspirin; and
- refer to medical care if symptoms are severe.

13 MEDICAL CONDITIONS

13.1 Introduction

The patroller may encounter a number of non-trauma related problems ranging from trivial to life threatening. A simple understanding of these conditions will help the patroller to render assistance to the casualty and communicate with medical personnel.

13.2 Diabetes

Diabetes Mellitus is a disorder where the body does not produce insulin or is not able to use it correctly. Normally the blood sugar level is under strict control. In diabetics the body cannot maintain this control and the blood glucose level can vary from very high to very low. Both extremes are life threatening.

Insulin, a hormone produced by the pancreas, regulates the blood sugar level by enabling glucose in the blood to cross cell membranes and enter cells. Without adequate insulin, glucose builds up in the blood stream (hyperglycemia). Too much insulin results in a fall in the blood sugar level (hypoglycemia).

In hyperglycemia, caused by inadequate insulin, the body will attempt to regulate the blood sugar level by excreting it through the kidneys, with body fluid loss proportional to the level of blood glucose. This fluid loss causes two of the classical symptoms of uncontrolled diabetes – polydipsia (excessive thirst) and polyuria (excessive urination).

Management of diabetes involves special attention to diet and exercise and usually requires treatment with tablets either to stimulate the cells in the pancreas to produce more insulin or to reduce resistance to the action of insulin or both, or injections of insulin.

13.2.1 CLASSIFICATION OF DIABETES

Insulin Dependent Diabetes Mellitus (IDDM), Type 1 or juvenile onset diabetes, is a condition in which the pancreas produces inadequate insulin. Therefore the body is unable to regulate the level of blood sugar (glucose). A Type 1 diabetic requires insulin injections and must carefully balance the amount of insulin used against the food intake and level of exercise. The complications of diabetes are usually related to the casualty's inability to control the blood sugar level by diet, exercise and insulin injections.

Non Insulin Dependent Diabetes Mellitus (NIDDM), Type 2 or maturity onset diabetes usually has a slow onset in middle-aged over-weight people. It is generally managed by diet control, medications, and exercise.

13.2.2 HYPERGLYCAEMIA (KETOACIDOSIS)

Hyperglycaemia is a serious complication of uncontrolled diabetes. This is a medical emergency with a significant mortality. It generally develops slowly, over a period of days. In diagnosed diabetics it occurs when insulin is not taken for several days, whereas in undiagnosed Type 1 diabetics, ketoacidosis may be the way in which the disease is first diagnosed. Ketoacidosis occurs when the blood sugar level has been high for a period of time. It is often associated with another illness or infection where extra insulin is required. Constant high blood sugar levels cause a build-up of lactic acid, and dehydration from over-excretion of body fluids. The acidosis and the dehydration lead to diabetic coma, which is a life threatening condition.

SIGNS AND SYMPTOMS OF SEVERE HYPERGLYCAEMIA

- Fatigue;
- extreme thirst and frequent urination;
- rapid, weak, thready pulse;
- a normal or slightly low blood pressure;

- air hunger manifested by rapid and deep 'sighing' respiration due to the body trying to excrete acid (in the form of carbon dioxide) from the lungs;
- there may be a sweet, fruity odour on the person's breath (caused by ketones, a by-product of the process, where a lack of insulin forces the body to use fat);
- dehydration with warm, dry skin, a dry mouth, and ultimately hypovolaemic shock;
- seizures;
- confusion or altered level of consciousness; and
- unconsciousness and if untreated, ultimately, death.

13.2.3 HYPOGLYCAEMIA (INSULIN SHOCK)

This represents a complication of medical treatment through too much insulin or oral hypoglycemic agents, insufficient glucose intake, or excessive physical activity. The blood sugar level falls and the brain is first affected. It requires constant blood sugar levels because unlike the rest of the body, the brain cannot store sugar. If normal blood sugar levels are not restored quickly, the casualty may become unconscious and suffer brain injury.

Hypoglycaemia is more likely to occur in the Ski Patrol setting.

SIGNS AND SYMPTOMS OF HYPOGLYCEMIA

- Irrational and aggressive behaviour is common in the person suffering from hypoglycemia (this is a result of the low sugar levels, and is not under conscious control);
- normal or slightly rapid respiration;
- rapid, full pulse (*Bounding Pulse*);
- low blood pressure;
- pale, cool, moist skin;
- trembling, shakiness of hands;
- dizziness and headache;
- yawning, desire to sit down and have a sleep;
- irrational thought processes;
- slurred speech; and
- fainting, seizures, and coma.

13.2.4 MANAGEMENT OF DIABETIC EMERGENCIES

It may be difficult to determine from the signs and symptoms whether a diabetic's problem is due to high or low blood sugar. Most diabetics, however, carry a portable pocket sized blood glucose monitor so the blood glucose level can be measured by someone who knows how to use the glucometer (the casualty's friend or someone familiar with glucometers), though they may not have it with them while engaged in snowsports. A glucometer measures the blood sugar level in units of millimols per litre (mmol/L).

Blood glucose levels of up to 15 mmol/L may pass unnoticed. At higher levels, symptoms including polydipsia, polyuria, tiredness, recurrent infections (such as thrush) and occasionally weight loss, begin to show.

13.2.4.1 The conscious diabetic

- Establish the likely cause by asking the casualty the questions "Have you eaten today?" and "Did you take your insulin today?" and "When did you last eat?". Usually the casualty will know what the problem is if previously diagnosed.

- The hyperglycemic casualty will have eaten, but not taken insulin whereas the hypoglycemic casualty will have taken insulin, but not eaten adequately, or have been involved in excessive exercise.
- The conscious diabetic, though confused, may be able to instruct the patroller in the use of the glucometer and in the administration of medications.
- For hypoglycemia, give the casualty oral 'sugar' in the form of jelly beans, barley sugar, soft drinks (not "diet" beverages), orange juice with added sugar or any other sweet substance.
- For hyperglycemia, help the casualty self-administer insulin then transport to medical care urgently.
- If the blood sugar cannot be measured, treat as for hypoglycemia and transport the casualty to medical care as soon as possible.

13.2.4.2 The unconscious diabetic

- Follow the **DRS ABC** principles. Medic Alert identification or diabetic treatment materials may be found on the casualty and will assist the patroller in determining management.
- If the blood sugar is tested and found to be very low, the casualty may need to receive glucagon by injection. Many diabetics carry emergency injectable *glucagon*, a drug which helps the body move glucose from various body stores back into the blood stream in situations of hypoglycemia. This may be administered by a doctor or other professionally trained person. In some cases a member of the family may be present and have undertaken training for this situation. Be sure about the credentials of any person before handing over such responsibility. Glucagon should produce an improvement in the conscious state in 15 minutes and the casualty should be transported to medical care. A second injection may be necessary. If glucagon is not available, seek medical care urgently.
- Give nothing orally. ***Oral glucose in any form*** (sweets or glucose drinks) ***should not be administered to unconscious diabetics*** even if the blood sugar is very low.
- If the blood sugar is tested and found to be very high or very low, the casualty needs urgent medical attention and must be transported to medical care as soon as possible.
- If the blood sugar cannot be measured then treat as for hypoglycemia. This will assist the hypoglycemic diabetic but will not worsen the condition of the hyperglycemic casualty.
- If there is no response to treatment, transport the casualty to medical care urgently.
- A casualty who has been unconscious should be transported to medical care for further assessment.

13.3 Epilepsy

13.3.1 INTRODUCTION

Epilepsy is a medical condition in which there is, from time to time, over activity in part of the brain causing abnormal physical movements or behaviour (a seizure, convulsion, or fit).

Seizures may be:

- abnormal movements which are commonly an uncontrolled spasm and jerking of the whole body (*tonic-clonic seizure*, formerly referred to as 'grand mal');
- abnormal movements involving just one limb or a small group of muscles (a simple or complex *partial seizure*, formerly referred to as 'focal'); or

- abnormal behaviour which is commonly a short trance like episode (an *absence seizure*, formerly referred to as 'petit mal') where the casualty stares blankly for a short time and does not respond to the surroundings.

The undiagnosed epileptic may first present with a seizure following the use of alcohol or drugs, when very tired, when emotionally stressed, or following a head injury. Children up to the age of 5 years may have a seizure (febrile convulsion) in response to a high fever associated with some other condition such as a respiratory infection.

The diagnosed epileptic is usually controlled by medications but may have a seizure precipitated by missed medication or in situations described above.

During a tonic-clonic seizure, the casualty may urinate, salivate (froth at the mouth), or vomit. There is usually a period of generalised muscle rigidity (the tonic phase) during which the casualty will not breathe and may become cyanosed followed by generalised jerking (the clonic phase) during which some respiratory movements occur.

The seizure may last several seconds or several minutes and is usually followed by a period of altered consciousness corresponding to the duration and severity of the seizure.

Rarely, the seizure will continue unabated (status epilepticus) and will not stop without specific anti-epileptic medications. This is a medical emergency and may be fatal. Epileptics prone to this condition carry Valium in the form of a liquid or gel, which must be administered rectally.

13.3.2 MANAGEMENT OF AN EPILEPTIC SEIZURE

Do not insert anything in the mouth during the seizure. Fingers may be bitten off and choke the casualty. Hard objects, like padded spoons can obstruct the airway or cause broken teeth.

- Help the person lie down but do not attempt restraint.
- Be aware of potential dangers to the casualty (sharp objects, rocks, traffic, etc).
- Place the casualty in the Lateral Recovery Position as soon as possible to clear and protect the airway and administer oxygen if available.
- Do not give anything to eat or drink until the casualty is fully alert.
- Medical consultation is necessary following a first seizure, a prolonged seizure (greater than 5 minutes) or if another seizure occurs before the victim has fully recovered from the first. Some epileptics who have seizures frequently may refuse medical consultation. If in doubt contact a doctor for advice.
- Drowsiness is common after seizures – allow the casualty to sleep under supervision.

13.4 Heart disease

13.4.1 INTRODUCTION

The heart is a very efficient muscular pump beating regularly from birth until death without rest. Heart disease is the most common cause of death in developed countries. In Australia it accounts for about one third of all deaths, second only to cancer. The majority of these deaths are caused by coronary artery disease, also called ischaemic heart disease, atherosclerotic heart disease or hardening of the arteries. This is a disease of lifestyle and, in the vast majority of people, is preventable.

13.4.2 ANATOMY AND PHYSIOLOGY

Review the anatomy and physiology of the heart in Section 2.3 **Circulatory System**.

13.4.3 CORONARY ARTERY DISEASE (CAD)

The heart receives its own blood supply from the left and right coronary arteries, which arise from the first centimetre of the aorta.

Coronary Artery Disease is the process of gradual narrowing and occlusion of the coronary arteries. The inner surface of the arteries becomes rough and irregular due to deposits of cholesterol and calcium (atheroma, atherosclerosis). If the coronary arteries are narrowed through spasm or atherosclerosis, blood flow is reduced and the heart muscle will not be supplied with enough oxygen to meet its need. The heart may malfunction and the casualty will experience angina or chest pain. Atheroma deposits can become a focus on which a blood clot can form and cause a sudden complete obstruction of the coronary artery. If this artery is large, the sudden obstruction may cause the death of a considerable area of heart muscle (myocardial infarction), or may cause an arrhythmia. Either of these events may be fatal.

Risk factors contributing to CAD include:

- hypertension (high blood pressure);
- elevated serum cholesterol;
- smoking;
- diabetes mellitus;
- obesity;
- lack of exercise;
- age;
- heredity.

The first six risk factors are modifiable through lifestyle.

CAD can lead to ischaemic heart disease and angina, heart failure, heart attack (also known as *acute myocardial infarction,* or AMI), or cardiac arrest.

13.4.4 ANGINA

This occurs if the heart's demand for oxygen exceeds the supply (myocardial ischaemia). Angina, therefore, generally occurs during times when the heart is working hard (e.g. physical or emotional stress), but can happen spontaneously with no obvious reason. In angina, there is no permanent damage to the heart muscle and the episode resolves spontaneously or with treatment. An attack of angina may however progress to a heart attack.

SIGNS AND SYMPTOMS

- The key symptom is pain, which comes on with exertion and is relieved by rest. The pain is described as being felt behind the sternum and may radiate to the jaw, upper arms (especially the left), or to the upper abdomen. It is often described as tightness or a squeezing sensation.
- During more severe attacks there may also be:
    - shortness of breath;
    - nausea; and
    - sweating.
- The casualty may be distressed and sweaty with pale or gray looking skin.
- The casualty may clutch at the chest.
- An attack may last up to twenty minutes.

MANAGEMENT

- Encourage the casualty to sit and rest (sitting or reclining may be more comfortable than lying down).

- Give Oxygen by face mask. Oxygen may be administered with pain relief, e.g. Methoxyfluorane and O_2 (Penthrox) or Entonox.
- Monitor pulse (and blood pressure if possible). Take note of the rate, rhythm, and strength of the pulse.
- Where it has been prescribed, assist the casualty in taking angina medication (*Glyceryl trinitrate* or *GTN*, known by the brand names of *Anginine*, *Isordil*, or *Nitrolingual Spray*). GTN causes the smooth muscle in the walls of the coronary arteries to relax and allows more blood to flow to the heart muscle. It often produces a headache, particularly in people who have not taken it before. The medication is placed (or sprayed) under the tongue or in the cheek and allowed to dissolve. If the pain has not eased after ten minutes, administer a second dose.
- If the pain has not resolved after twenty minutes, or if it is the first episode of angina, the casualty should be transported to medical care urgently being monitored constantly during transportation.

13.4.5 ACUTE MYOCARDIAL INFARCTION (HEART ATTACK: AMI)

When an area of heart muscle is permanently deprived of oxygen the muscle cells die. This usually occurs when a coronary artery (or one of its branches) previously narrowed by atheroma or spasm becomes suddenly blocked by a blood clot. The damaged muscle is replaced by scar tissue and the consequences for the casualty depend on the size of the damaged area.

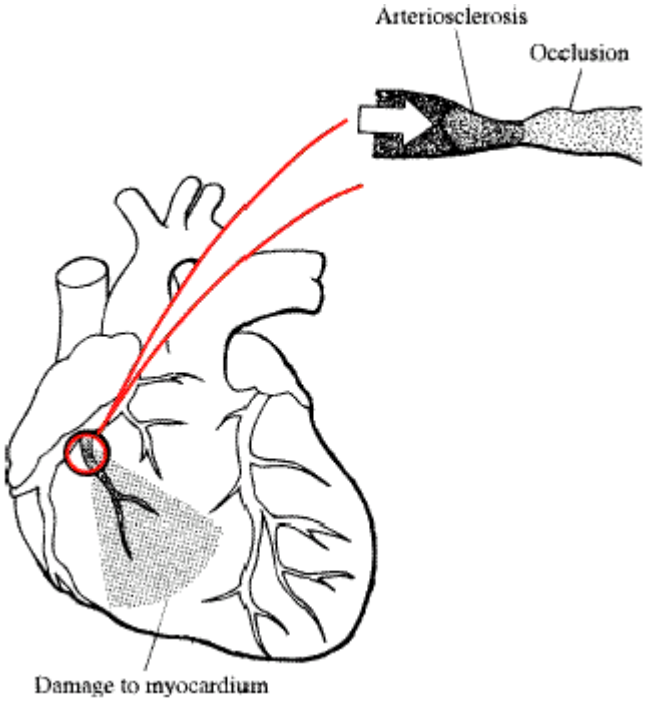

Figure 271 Damage to the myocardium

Some of the consequences of an AMI are:

- Sudden death from *arrhythmia*. About 40% of all casualties experiencing an AMI die before reaching hospital. Arrhythmia (abnormality of heart rhythm) prevents any effective pumping action of the heart. The two most dangerous arrhythmias are *ventricular fibrillation* (a disorganized quivering of the heart muscle), and A*systole* ("flat line" - no beat at all). These (and other) arrhythmias present as cardiac arrest.
- Cardiogenic shock. This is an early complication of a large AMI where the heart is unable to sustain a normal blood pressure (see Section 6.2.2.2 **Cardiogenic Shock**).

- Congestive heart failure – refer to Section 13.4.6 **Congestive cardiac failure (Heart failure: CCF)** below.

SIGNS AND SYMPTOMS

- Discomfort or chest pain behind the sternum (retrosternal) that may come on suddenly or over several minutes, and be described as tightness, heaviness, fullness or squeezing;
- pain may be severe, moderate, or mild;
- pain may radiate to (or even be limited to) the neck, throat, jaw, shoulders, back, and either or both arms to the wrists or hands;
- sudden onset of weakness, nausea, and sweating;
- breathlessness;
- pulse may be rapid or irregular and may feel thready;
- collapse due to non-fatal arrhythmia; or
- sudden death due to an arrhythmia (if CPR is commenced immediately, and an Automatic External Defibrillator is available, the probability that the casualty may be resuscitated is improved).

In comparison to angina, the pain from myocardial infarction is generally more severe, lasts longer, might not be related to exertion or stress and is not relieved by GTN. The pain may come on at any time and frequently occurs at night. Occasionally people (especially diabetics) can suffer a 'silent' MI with no pain, and may suddenly collapse, pulseless and unconscious.

Heart attack warning signs usually last for at least 10 minutes. If the signs are severe, or get worse quickly, act immediately.

Some people who experience heat attack may attribute their symptoms to indigestion.

MANAGEMENT

- Reassure and try to calm the casualty. Anxiety and agitation may contribute to arrhythmia and the risk of sudden death.
- Help the casualty into a comfortable resting position (sitting or lying).
- Administer Oxygen by face mask. This may limit the area of muscle damage and reduce the risk of abnormal cardiac rhythm. Oxygen may be administered with pain relief, e.g. Entonox or Penthrox.
- Give Glyceryl trinitrate (GTN) or the casualty's own prescribed medication under the tongue if it is available.
- Call for an ambulance (preferably MICA or Intensive Care) to transport the casualty to the nearest hospital. Ensure that the ambulance service coordinator understands that the casualty has symptoms of myocardial infarction.
- Monitor pulse, respirations, and blood pressure (if possible) regularly.
- In a ski resort contact the resort doctor to determine the best mode of transport to the medical centre.
- Anticipate the possibility of a cardiac arrest, and be prepared to commence CPR and Defibrillation.

Figure 272 Management for heart attack

13.4.6 CONGESTIVE CARDIAC FAILURE (HEART FAILURE: CCF)

CCF is the situation where the heart is unable to pump blood effectively and a build up occurs in the venous circulation (in the lungs and in the veins returning deoxygenated blood to the heart). CCF can develop slowly as a result of abnormality or damage to the heart valves, sustained high blood pressure, coronary artery disease or disturbances in heart rhythm. Acute CCF can occur following Acute Myocardial Infarction when there is extensive muscle damage or sudden damage to a heart valve.

The heart rate increases and one or both of the ventricles can enlarge. Cardiac output falls and blood tends to pool in the lungs, mainly in the capillaries and veins, causing pressure to rise in these vessels. When this capillary pressure exceeds 25mmHg, plasma passes through the capillary walls into the alveoli and these tiny air spaces of the lungs become filled with fluid (Pulmonary Oedema).

SIGNS AND SYMPTOMS OF ACUTE PULMONARY OEDEMA

- Rapid onset of shortness of breath at rest;
- marked anxiety due to hypoxia and a drowning feeling;
- pale grey or cyanosed appearance;
- cold and clammy skin;
- rapid, laboured respirations, with rattling or wheezing and there may be a cough with pink frothy sputum;
- rapid weak pulse; and
- shocked appearance (cardiogenic shock).

MANAGEMENT

- Help the casualty sit-up with legs dependent (dangling down);
- administer Oxygen by face mask;
- reassure the casualty;
- arrange urgent transportation to medical care, monitoring vital signs in transit; and

- even if the blood pressure is low, avoid lying the casualty down and do not elevate the legs as these manoeuvres will worsen venous pooling and exacerbate the symptoms.

13.4.7 CARDIAC ARREST

When the heart stops pumping adequately, circulation of blood to the brain and body ceases, resulting in rapid loss of consciousness and cessation of breathing. Irreversible brain damage occurs after 4–6 minutes, and the casualty dies soon after.

Cardiac arrest commonly follows myocardial infarction due to coronary artery disease but can also result from electrocution, suffocation, shock, drowning, and as a complication of hypothermia. Cardiac arrest usually occurs in an older age group but it can occur in a young person with abnormal electrical conduction pathways in the heart.

Cardiac arrest can be due to Asystole, a complete absence of cardiac muscle contraction, or Ventricular Fibrillation(VF), where the heart muscle twitches and trembles in a disorganised fashion, and a number of other cardiac arrhythmias such as pulseless *Ventricular Tachycardia* (VT) and *Pulseless Electrical Activity* (PEA - also known as *Electro-Mechanical Dissociation* or EMD).. Cardiac Arrest is fatal unless CPR is instituted immediately and effectively. The availability and use of an Automatic External Defibrillator (AED) also increases the chance of survival. Cardiac arrhythmias are divided into 'shockable' (VF/Pulseless VT) where an AED shock may be applied, and 'non-shockable' rhythms (asystole/PEA). The AED analyses the casualty's arrhythmia to determine whether to deliver a shock or not.

SIGNS AND SYMPTOMS

- Sudden collapse;
- an unconscious casualty;
- absent or abnormal respirations; and
- there may be a history of chest pain or tightness before the collapse.

MANAGEMENT

- **DRS ABCD**[1].
- Commence CPR and continue until medical care arrives, until the casualty recovers, or, in the case of hypothermia, until the casualty is re-warmed.
- AED's are carried by all ambulances and are available in most ski resorts. A defibrillator is often the only way to shock the heart back into a normal rhythm, and this should be called for and used at the earliest opportunity (refer to Section 4.7 **Defibrillation** for further details).

14 POISONING, BITES AND STINGS

14.1 Poisoning

A poison is a substance (other than an infectious substance) that is harmful to human health if ingested, inhaled, injected, or absorbed through the skin. Substances that are benign or therapeutic at low levels (for example, pharmaceuticals and herbal remedies) may be poisonous at higher concentrations. Toxins are poisons that are produced by living organisms. Venoms are toxins that are injected by an organism. Poisons can cause harm by a wide range of mechanisms

The motivation for poisoning can be either accidental or deliberate. The patroller must remember the danger of being exposed to the poison, especially when the poisoning occurs by absorption or inhalation. In these situations, do not attempt to treat the casualty until the situation has been made safe.

There is a great variety of substances that can cause poisoning, and whatever the cause, medical care should be obtained as soon as possible. ***Never attempt to make the casualty vomit*** unless instructed to do so by the Poisons Information Centre, the relevant Material Safety Data Sheet (MSDS), or the doctor. The Poisons Information Centre actively discourages the use of Ipecac syrup.

14.1.1 POISON INFORMATION CENTRE

The Poison Information Centre can be contacted on 13 11 26.

This phone number will also work from a mobile phone. When speaking to the Poisons Information Centre, be ready to provide this information:

- details of the poison container (if available, have the container of the poison at the phone, but do not come into contact with the contents);
- the amount that was in the container, and is in it now;
- when the poison was taken; and
- what symptoms the casualty is showing.

14.1.2 MATERIAL SAFETY DATA SHEETS

Employers are now obliged to ensure that all dangerous goods and hazardous substances are labeled and that a Material Safety Data Sheet (MSDS) is readily available to any employee using the substance.

The MSDS contains 4 major sections:

- Product Identification, which allows the correct identification of the substance which is causing harm;
- Precautions for Use, including details of the hazards that may arise through contact;
- Health Hazard Information, which details the hazards and the specific first aid measures for the substance in case of ingestion, inhalation, absorption, or contact with the eyes or skin; and
- Safe Handling Information, providing information on the handling of spills, fire and explosion hazards, and storage and transport details.

The MSDS is an alternate source of information to the Poisons Information Centre in the management of poisoned casualties.

14.1.3 SIGNS AND SYMPTOMS OF POISONING

Poisons can cause a wide range of symptoms, including:

- Burns around the lips, throat, or mouth;
- nausea and/or vomiting;
- excessive salivation or sweating;
- abnormal respirations or pulse;
- unconsciousness;
- convulsions or seizures;
- difficulty breathing;
- respiratory arrest; and
- cardiac arrest.

Some of the signs to look for on or around the casualty include:

- constriction or dilation of the pupils;
- presence of a poison container near the casualty;
- smell of the breath may give clues (e.g. alcohol, petrol, kerosene, etc).

14.1.4 GENERAL MANAGEMENT PRINCIPLES

- Do not give anything by mouth if the casualty is unconscious.
- The rescuer(s) must be aware of the mechanism of poisoning, and protect against contamination themselves. The environment around the casualty, as well as the casualty's clothes and skin, may pose a danger. Personal Protective Equipment (PPE) may be required to protect the rescuer(s).
- Monitor vital signs and manage any changes by resuscitating as necessary. Be careful to avoid self-contamination with any poison around the casualty's mouth if undertaking Rescue Breathing. Mouth to mask resuscitation or the use of a Bag-Valve-Mask are ideal or if not available, mouth to nose.
- Where the poisoning agent is known, refer to the Material Safety Data sheet (MSDS) which gives specific first aid management for the poison. If the MSDS is not available at the incident scene, it should be sought urgently either through the Poisons Information Centre or by asking bystanders or the casualty.
- Collect any sputum or vomitus for laboratory analysis and transport with the casualty.
- Transport with the casualty any containers suspected of containing the poisoning agent and the MSDS if available.

14.1.5 MANAGEMENT OF INGESTED POISONS

- Identify the poison and the amount swallowed;
- monitor vital signs and manage any changes;
- if conscious, give a sip or water to wash out the casualty's mouth;
- call for medical advice and follow directions given;
- transport to medical care; and
- only induce vomiting if directed to do so by the MSDS, Poisons Information Centre, or a doctor.

Do not induce vomiting if:

- the casualty is unconscious or convulsing;
- the poison is a known corrosive agent or there are burns to the lips, mouth, and throat (what burns on the way down will also burn on the way up); or

- the poison contains petroleum products (e.g. petrol, kerosene, or furniture polish) which may enter the lungs during the vomiting and cause a potentially lethal chemical pneumonia.

14.1.6 MANAGEMENT OF INHALED POISONS

- Remove the casualty from the contaminated atmosphere as quickly as possible without risking the safety of anyone other than the casualty, to an area with fresh air;
- monitor vital signs and manage any changes;
- administer Oxygen by face mask;
- attempt to identify the poisoning agent; and
- transport to medical care.

14.1.7 MANAGEMENT OF INJECTED POISONS

- If swelling is apparent at the injection site, remove all rings and watches etc.;
- apply a constricting bandage as for snake bite;
- monitor vital signs and manage any changes;
- attempt to identify the poisoning agent and seek advice from the Poisons Information Centre; and
- transport to medical care.

14.1.8 MANAGEMENT OF SURFACE CONTACT POISONS

These include herbicides, pesticides, corrosives, acids, alkalis, and some petroleum distillates.

- Remove the agent from the skin by:
  - removing contaminated clothing;
  - flooding the area with copious quantities of water, including directing a stream of water under the clothing as it is being removed;
  - washing gently with soap and water, and rinse well.
- monitor vital signs and manage any changes;
- refer to specific management advice on the MSDS, or seek advice from the Poisons Information Centre; and
- transport to medical care.

  If the poison enters the eye, flood the eye with saline or cold water for at least 15 minutes, while holding the eyelid open.

14.2 Bites due to snakes, spiders, ticks and other biting insects

14.2.1 SNAKE BITE

Snake bite normally occurs on the extremities, especially the feet and ankles. Snake venom affects the body by:

- altering blood clotting properties which can cause internal haemorrhage; and
- affecting the nervous system causing progressive paralysis and possible death from asphyxia.

SIGNS AND SYMPTOMS

These signs and symptoms can appear in any combination and in any order:

- paired fang marks may or may not be present (often there is only a single mark or a scratch);
- headache;
- nausea and vomiting;
- pain in the abdomen;
- blurred or double vision, or drooping eyelids;
- respiratory weakness, failure and arrest;
- difficulty in speaking, swallowing, or breathing;
- local node involvement (the casualty has swollen or tender glands in the groin or axilla of bitten limb), and;
- limb weakness or paralysis;
- occasionally, initial collapse or confusion followed by partial or complete recovery;
- discolouration of the skin or localized redness or bruising at the bite site (uncommon in Australia).

MANAGEMENT

The aim of management of snakebite is to delay the absorption of the venom into the circulation, to provide time for the casualty to be transported to medical care where antivenom can be given. The patroller should:

- Calm and reassure the casualty, who should remain resting and quiet until arrival at the medical centre.
- Apply the Pressure Immobilisation Technique. Apply a broad pressure bandage over the bite as soon as possible. Elasticised bandages 10-15cm wide are preferred over crepe bandages but, if neither are available, improvise using any flexible material that can be torn into strips 7cm to 10cm wide. The bandage should be firm; you should not be able to easily slide a finger between the bandage and the skin. To further immobilize if the bite is on a limb, apply another bandage starting at the fingers or toes and extending upward covering as much of the limb as possible. If only ONE bandage is available for a limb bite, the bandage should extend from the fingers or toes up past the bite site and as far up the limb as possible.
- Immobilise the bandaged limb in a splint. Keep the casualty and the limb completely still. If the casualty has not been bitten on a limb, keep the casualty calm and still, and seek urgent medical care.
- Monitor vital signs and manage any changes. Do not leave the casualty alone.
- If possible, bring a doctor to the casualty. Otherwise, transport to medical centre after alerting the staff to the nature of the bite.
- If possible, keep the bitten area below the level of the heart.

Do not wash or cut the bitten area, as this will hinder the effectiveness of an anti-venom detection kit if used. ***Do not suck the bite*** as this will expose the patroller to danger from the venom. Do not use an arterial tourniquet. Do not remove the bandages or splint until with medical aid.

Note: The Pressure Immobilisation Technique described above is also used for Funnel Web Spider bites, Blue-Ringed Octopus, and Cone Shell. It is NOT recommended for other spider bites (including Redback), jelly fish stings, fish stings such as stonefish, or stings from scorpions, centipedes, or beetles.

Figure 273 (Bandaged) snake bite to lower leg:
Apply a firm pressure bandage over the bite, then another to the limb from the toes upwards

Figure 274 (Bandaged and Splinted) Snake or spider bite

14.2.2 SPIDER BITE

There are only two significant potentially lethal spiders in Australia:

- Funnelweb, which may inflict a lethal bite but can be treated with antivenom.
- Redback spider. The venom of the Red-back spider works slowly and there is usually time to get to medical care. Bites are rarely fatal in adults but can threaten the life of a child.

SIGNS AND SYMPTOMS

Funnel Web:

- typically milder pain with little local reaction;
- tingling around the mouth;
- profuse sweating and salivation;
- abdominal pain;
- muscle twitching;
- respiratory distress; and
- confusion progressing to unconsciousness.

Redback:

- severe pain at bite site which becomes hot, red, and swollen;
- intense local pain that increases and spreads;
- profuse sweating especially at the bite site;
- swollen tender glands in the groin or armpit of the bitten limb; and
- nausea, vomiting, and abdominal pain;

MANAGEMENT

Funnel Web:

- treat as for snakebite using the Pressure Immobilisation Technique;
- commence CPR if indicated; and
- transport urgently to medical care.

Redback:

- keep the casualty under observation;
- apply ice or cold compress to reduce pain, for period up to 20 minutes; and
- transport to medical care if the casualty is a young child or collapse or severe pain occurs.

Note: The pressure immobilization technique may increase local pain and is unsuitable for the slow-acting venom of the Redback.

Others:

- Treat symptomatically – typically applying ice or a cold compress to relieve pain;

14.2.3 TICK BITE

The bush tick is most commonly found in humid areas. When it bites, it tends to bury itself in hairy areas of the body such as the scalp or groin. It survives by sucking on its host's blood. In doing this, it exudes a toxin that can lead to paralysis.

SIGNS AND SYMPTOMS

- the tick can be seen;
- the bite area is swollen and inflamed;
- lethargy;
- muscle weakness, especially in children
- unsteady gait;
- double vision;
- difficulty swallowing or breathing;
- there is occasionally pus present as the head of the tick can excite an infective response by the body; and
- paralysis is a late sign.

MANAGEMENT

- Using fine curved forceps, or equivalent, press the points down onto the skin on either side of the front part of the tick, then close the points and lift or lever the tick out intact. The tick should be removed slowly allowing it to remove its mouth parts.
- Alternatively, a “lasso” of thread (knot) may be positioned low around the mouth parts and steady upward traction applied opposite the direction of entry.
- After removal of a tick, the casualty should apply an antiseptic and be advised to consult their doctor, to check that no further treatment is required.
- If the casualty develops a rash, persistent headache, fever, aching joints or has a history of allergy then seek immediate medical advice.

14.2.4 STINGS

14.2.4.1 Bee stings

A bee sting can be significant as many people are highly allergic to bee venom and can suffer anaphylactic shock after being stung. (See Section 6.2.2.3 **Vascular Dilation** for description and management of anaphylactic shock.)

MANAGEMENT

- Remove the barb by scraping it off;
- do not squeeze or pull on the sac as this may inject further poison into the body;
- apply an ice pack and elevate the area; and
- assess for signs of anaphylactic shock and treat as necessary.

14.2.4.2 Jellyfish Stings

There are a number of venomous jellyfish in Australia. The Large Box Jellyfish and Irukandji Jellyfish of the tropics are potentially fatal. Other jellyfish bites are not serious.

When a sting occurs, pieces of tentacle or unfired stinging cells (*nematocysts*) may remain on the casualty’s skin or clothing.

SIGNS AND SYMPTOMS

- Visual evidence of tentacles;
- an inconspicuous mark which may develop a red flare, goose pimples or orange-peel texture, or profuse seating only at the sting site;
- an irregular blotchy wheal, white wheals with a surrounding red flare, or multiple whip-like wheals on the skin;

- a frosted ladder pattern ,may be seen in the first few minutes, with later blistering or darkening of the skin
- pain ranging from mild irritation to severe or sharp burning pain
- pain in the lymph nodes in groin or armpits;
- generalized muscle aches, ranging to severe muscle cramps in the limbs, chest, or abdomen; and
- In severe stings:
    - difficulty or cessation of breathing;
    - cardiac arrest;
    - severe pain;
    - restlessness and irrational behaviour;
    - nausea and vomiting, headache;
    - collapse; and
    - profuse sweating, sometimes only in the sting area.

MANAGEMENT

Tropical Jellyfish:

- remove the casualty from the water and restrain if necessary;
- call for urgent medical assistance;
- commence CPR as indicated;
- liberally wash the stung area with Vinegar (do **not** use fresh water);
- if Vinegar is not available pick off any tentacle remnants carefully and wash with seawater
- do not squeeze or pull on the sac as this may inject further poison into the body;
- apply cold packs or wrapped ice for pain relief and elevate the area; and
- assess for signs of anaphylactic shock and treat as necessary.

Anti-venom is available for some multi-tentacled box jellyfish stings. Casualties who initially appear stable but experience severe symptoms in the following 30 minutes may be suffering Irukandji syndrome and need urgent medical care.

“Bluebottle” or Non-tropical Jellyfish:

- rest and reassure the casualty and keep under observation;
- do not allow rubbing of the sting area;
- pick off any tentacle remnants carefully;
- rinse the sting area with seawater to remove invisible stinging cells; (and)
- immerse the sting area in hot water for 20 minutes, or if not relieved by heat or not available use cold packs or wrapped ice for pain relief; and
- if pain persists or is generalised, if the sting area is large (half a limb or more) or involves sensitive areas, seek medical assistance.

Other Non-tropical Jellyfish:

- rest and reassure the casualty and keep under observation;
- do not allow to run the sting area;
- rinse the sting area with seawater (not fresh water) to remove invisible stinging cells;
- apply cold packs or ice for pain relief; and

- seek medical care if pain is not relieved, the sting area is large, or generalized pain develops.

14.2.4.3 Other stings

There are a large number of insects that can cause severe reactions; e.g. ‘Jumper Jack’ ants or wasps. Stings of these other insects should be assessed and treated as for bee stings.

15 OTHER INJURIES DUE TO TRAUMA

15.1 Electrical injuries

15.1.1 INTRODUCTION

Each week in Australia approximately thirty people are unintentionally injured or killed by electricity.

15.1.2 FACTORS AFFECTING ELECTRICAL INJURIES

Five main variables affect the type and severity of injury:

- the voltage and current of the electricity;
- the type of current;
- the duration of contact with the current;
- the site and surface area of the contact (which determines the resistance to current flowing); and
- the pathway of current through the body.

15.1.2.1 Voltage, current and resistance

The resistance of the body tissues to electricity is different for each tissue measured. Connective tissue has the most resistance, while nervous tissue has the least so the extent of injury will be vary with tissue type because halving of the resistance will double the current at a particular voltage. Electricity tends to seek the path of least resistance so nervous tissue is at greatest risk of damage. Nervous tissue also is the least likely to regenerate.

The energy dissipated in the body during an electric shock is a function of:

$$\frac{\text{Voltage} \times \text{Voltage} \times \text{Time}}{\text{Resistance of the electrical path through the body}}$$

15.1.2.2 Duration, type and intensity of current

The current and the time for which it flows determine the energy released into the body tissues. This energy creates heating effects and consequent damage to tissues as well as disruption of normal electrical impulses within the body; e.g. the heart's pacemaking signals. The longer the time of contact, the greater is the damage. A very short duration, high voltage electric shock may cause less damage than a low voltage, long duration shock; e.g. a lightning strike versus a domestic electric shock.

Electrical power is provided as one of:

- direct current (DC), such as that provided by lightning, a car or torch battery; or
- alternating current (AC), which is used for household supply and most electrical distribution lines (overhead wires etc).

Alternating current cycles between positive and negative flow and this change causes muscles to contract (*tetanic contraction*). An outstretched hand which touches a live wire will contract and 'grasp' the wire, and be very difficult to release, thereby increasing the exposure time.

The table below indicates the effects on the body of different currents at standard supply voltage in Australia (230 volts). A 4 amp current delivers a similar amount of energy into the body in 10 milliseconds as a defibrillator.

1-2 milliamps	Tingling sensation of the skin
5-10 milliamps	Painful sensation
10-20 milliamps	Tetanic muscle contraction
30-90 milliamps	Respiratory arrest due to contraction of the diaphragm and intercostal muscles
100 milliamps	Ventricular fibrillation
2-5 amps	Cutaneous burns
5-10 amps	Asystole and death

Table 12 Effects of increasing current through the body at 230 volts

15.1.2.3 Site and surface area of contact

Different parts of the body have different electrical resistance, so the point of entry will influence how much electricity flows through the body. A larger surface area presents a greater resistance but the condition of the surface is also important. Wet dirty skin provides less resistance than clean dry skin.

15.1.2.4 Pathway of electrical current

Current passing directly through the brain will produce greater damage than a similar current passing through muscle. Studies have suggested that the most lethal path is from hand to hand, across the chest because electricity moves directly through the heart, and is likely to induce ventricular fibrillation and cardiac arrest.

15.1.3 CLINICAL EFFECTS

- Heart
  Arrhythmias are common after electrocution. Ventricular fibrillation or asystole can cause cardiac arrest. Ventricular fibrillation occurs more often with low voltage shocks; e.g. from household appliances and other electrical sources less than 1000 volts. Asystole occurs more with higher voltage shocks; e.g. lightning or high tension wires.
- Brain
  After electrocution, respiratory arrest may occur due to ‘paralysis’ of the respiratory centre in the brainstem. There may also be fitting, confusion, and variable depth of coma or paralysis after an electric shock.
- Skin
  Burns often occur on the skin after a shock. The entry and exit wounds can be small and may lead to underestimation of the extent of deep tissue damage caused by the current. It is also not unusual for the exit burn to be absent.
- Deep Tissues
  Frequently, there is severe damage to muscle, blood vessels, and nerves after an electric shock. Much of this tissue damage does not become evident until later. Muscles damaged by an electric shock may swell inside their sheaths causing an increase in pressure which cuts off the blood supply to the muscle (see also Section 9.4 **Compartment syndrome**). Muscle fibres damaged by electrocution break down releasing the protein *myoglobin* which can block the kidneys causing renal failure some time after the electric shock.

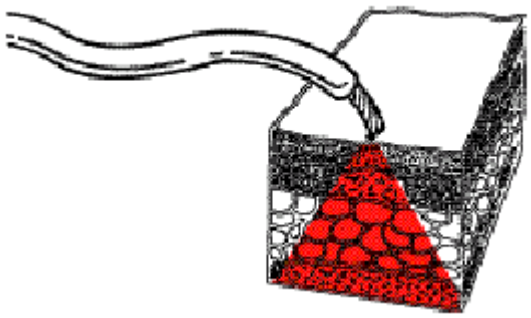

Figure 275 Tissue damage from electric shock

- Fractures and Dislocations
  Falls or convulsions caused by electrocution can lead to bone and joint injuries. Posterior dislocation of the shoulder joint should be anticipated in a casualty suffering a convulsive electric shock.

15.1.4 MANAGEMENT

- Follow the **DRS ABC** plan – isolate the electrical supply before attempting to rescue casualty or treat any injuries. Check for any concealed electrical supplies beneath the casualty or elsewhere.
- If there is any doubt, do not attempt to treat the casualty. Do not rely solely on objects such as rubber-soled shoes and plastic mats to provide insulation; insulating properties may have deteriorated with time.
- When the electricity is off, and the area is safe to enter, assess and manage the casualty following standard protocols. The first contact with the casualty should be made with the back of the hand just in case a 'live' electricity supply has been missed. An electric current to the palm will cause the muscles of the hand to contract and grip an object whereas contact with the back of the hand will repulse the hand and limit the shock received. Electricity is not stored within the body, so there is no danger in touching someone who has been electrocuted, but is now isolated from the supply.

15.2 Amputations

The amputation of any body part, regardless how minor, is a very traumatic event. The casualty must be given constant reassurance. If a casualty has sustained an amputation of a body part, the patroller should search for the part at the incident scene. Specific management for an amputation injury is to:

- place into a clean water-tight (e.g. plastic) bag, and seal;
- place the plastic bag into a second container filled with cold water (approximately 4°C), not ice or snow;
- never place amputated parts directly on ice or in dry dressings; and
- ensure that the amputated part is transported with the casualty, but do not delay transport searching for a missing part.

Otherwise, manage the casualty according to any other injuries.

15.3 Crush injuries

The term 'crush injury' includes any situation where a casualty is crushed by a heavy object or objects, or anything which applies a crushing force to a body part.

Where a crushing force is applied for more than one hour to a major muscle mass, a *crush syndrome* complication may occur. The crush syndrome results from the production of harmful chemicals from the damaged muscles and the release of these chemicals into the blood stream after the removal of the crushing force. Crush syndrome may result in sudden death, shock, or other circulatory and respiratory emergencies.

Removal of the crushing force is the priority for management, noting that:

- all crushing forces should be removed immediately after the crush injury if this is physically possible without endangering the patroller, bystanders, or the casualty (any danger solely to the casualty must be assessed against the need to remove the force as quickly as possible);
- if a crushing force is applied to the head, neck, chest or abdomen, and is not removed promptly, death may occur due to respiratory or circulatory failure, or hypovolaemic shock;
- any object crushing a limb must be removed as soon as possible; and
- if the time that the injury occurred is ***known to be over one hou***r before the removal of the crushing force, the patroller must be aware of the possibility of crush syndrome and manage the incident accordingly.

Where Crush Syndrome is a known risk (such as in the preceding point), and a medical team is expected to arrive at the scene within a reasonable time, it may be appropriate to delay the removal of the crushing force. If Crush Syndrome develops, it may be dangerous to the casualty to remove the crushing force without an emergency medical team present and able to manage the casualty's recovery.

MANAGEMENT

- Remove the crushing force as quickly and gently as possible, without exposing any person to danger;
- obtain medical assistance to the site, especially where the casualty cannot be released;
- keep the casualty comfortable; and
- assist the medical team on arrival.

Where a casualty suffers injury through a crushing force, it will usually not be feasible to continue treatment beyond the examination until the crushing force is removed, and the patroller will be restricted to monitoring the casualty's Vital Signs until further assistance arrives.

15.4 Eye injuries

15.4.1 FOREIGN BODIES

The conjunctiva and cornea are designed to protect the eye from injury and are well supplied with nerves. Any object that touches the eyelashes, conjunctiva, or cornea causes an instantaneous blink reflex, which is an attempt to prevent the object entering the eye. Any foreign body that penetrates this defense and lodges on the conjunctiva or cornea causes intense pain and irritation. The eye produces copious tears in an attempt to wash out the object, and the eyelids spasm closed.

Small foreign bodies often lodge under the upper eyelid. These can be removed using a cotton-bud or the corner of a clean handkerchief moistened using saline or the casualty's own saliva, after rolling back the eyelid over a matchstick. While it is safe for a patroller to remove small foreign bodies from under the eyelids or on the conjunctiva, only a doctor should attempt the removal of embedded or large foreign bodies, or foreign bodies on the cornea.

A penetrating foreign body is an emergency, and the casualty should be transported to a specialist medical facility as quickly as possible.

MANAGEMENT

- Small foreign bodies may be removed as above and the eye covered with
- a clean eye patch or folded handkerchief until the irritation subsides;
- embedded foreign bodies are treated by covering the injured eye with a clean dressing and transporting to medical care; and
- penetrating injuries are stabilised by covering the injured eye with a protective shield (such as a paper cup), covering both eyes to prevent movement of the injured eye, and transporting to medical care with the casualty sitting up if possible (usually air transport, with medical attendance, is preferred).

15.4.2 EYE BURNS

Burns of the eye may be caused by heat or chemicals. A special burn of the eye is caused by Ultraviolet light; for further details refer to Section 12.3 **Snow glare or snow blindness**.

Heat burns are often associated with burns of the face, especially the eyelids. This is a serious burn which requires specialist treatment. Management requires the application of a clean dressing and urgent transport to medical care.

Chemical burns are usually caused by acids or alkalis, the latter being more serious. Management involves:

- immediate flushing of the eye with copious clean water for a period of 20 minutes;
- seeking information from the Material Safety Data Sheet or Poisons Information Centre (if this information is obtained, keep it with the casualty);
- application of a clean dressing to the effected eye(s); and
- transport urgently to medical care.

15.4.3 OTHER EYE INJURIES

15.4.3.1 Eye lacerations

Laceration of the eyelid requires skilled suturing to prevent distortion of the eyelid when healed. Apply a clean dressing and transport to medical care.

Laceration of the eyeball is an emergency. Management is as for a penetrating injury of the eye.

15.4.3.2 Eye contusions

Bruising may be anything from a common 'black eye' to a major facial injury. Where the eyeball or eyelid is damaged, management is as for a penetrating eye injury.

15.5 Dental trauma

In treating cases of dental trauma, be aware that:

- dental injuries will involve exposure of the patroller to the casualty's body fluids, and gloves must be used;
- there is likely to be an associated injury to the head or spine; and
- the mouth must be checked for fragments of teeth as well as dental devices such as full or partial dentures, or orthodontic appliances.

Two common types of dental injury occur.

A *dental avulsion* occurs where a tooth is lost but is intact. Management is to:

- retrieve and retain the tooth, teeth, or fragments if possible;

- provide gentle irrigation with clean water or milk, or have the casualty suck the injury site and parts clean themselves (do not scrub or rub);
- replace the tooth or teeth into socket(s) quickly, if possible (to determine the correct position, have the casualty close teeth to a "normal" full closure bite position and reassess);
- stabilise the injury using a piece of aluminium foil folded 2 to 3 times on itself and moulded over the teeth involved as well as the adjacent teeth; and
- transport to medical care.

A *dental fracture* involves the partial loss of a tooth or teeth. Management is to retrieve and retain fragment(s), and transport to medical care.

In either case, should it be necessary to store fragments or whole teeth, this may be done by storing within:

- the casualty's own mouth, taking precautions to ensure the casualty will not swallow anything;
- ice or snow;
- a container of milk or water.

Any casualty with a dental injury should be referred to a dentist for professional treatment.

15.6 Avalanche Casualties

Although uncommon in most Australian snowfields, avalanches do occur and a patroller should be aware of specific precautions concerning casualties.

DANGER!

Rescuer safety remains the number one priority at all times. Even small avalanches can have large consequences. Do not underestimate the dangers involved in snow pack instabilities. Snow science, stability assessment and safe travel techniques are learned skills that require specialised training, practical experience and constant vigilance. Keep the immediate area clear, interview witnesses gather bystanders in a safe location to assist with the rescue, and look for any entry tracks around the avalanche field that may give a clue to the whereabouts of any casualties. Once you are SURE that the avalanche field is safe to enter, an organized search may begin. Avalanche Search and Rescue has its own unique skill set and organized structure that is not covered by this manual. If in any doubt about safety, a rescue should be referred to trained personnel. Ignorance of the danger signs or a lack of knowledge about snow stability is not an excuse to initiate a rescue and put the rescuers in danger. Skills in these areas, as well as the correct techniques and equipment, are necessary to maximise rescuer safety.

Time is Life! Always remember that TIME is critical in avalanche rescues. The best chance of survival is by rescue from the victims own companions. Often, by the time a rescue team is informed and mobilised, the time factor is already very much against survival. Avalanche casualties recovered within 15 minutes have a 90 percent chance of survival if they have not suffered trauma during the avalanche. This chance of survival drops to 50 percent after 30 minutes. After 35 minutes, chances of survival rapidly diminish and become highly dependent on whether the casualty has an air pocket for breathing whilst awaiting rescue. After 2 hours of burial the chances of survival are practically zero.

An avalanche may involve multiple casualties, who may be recovered at different times during the rescue. Triage must be carried out continuously as casualties are found, so that the priority of care can be adjusted if necessary to suit the available number of rescuers. Treat casualties as they present, but be mindful of these factors:

- Send for help as soon as possible, and work with the emergency services that will likely be part of the rescue effort.
- Asphyxiation is the major cause of death in avalanches[(1)]. Full resuscitation, including active and passive external rewarming, is indicated for any avalanche

casualties who do not show evidence of a life threatening trauma that cannot be survived (for e.g., Decapitation, Truncation). ***The priority for buried casualties is to establish and maintain a clear airway***, not removal from the debris. Airway always takes precedence.

- Hypothermia is the main concern after a casualty is extricated. It normally takes more than 35 minutes for moderate to severe hypothermia to occur while buried. However, once extricated, the risk of hypothermia increases and it is important to:
    - warm casualties as effectively as possible, and especially to protect them from further cooling;
    - handle all hypothermic casualties gently, as aggressive handling may cause Cardiac arrhythmias;
    - provide transport to higher medical care for further monitoring;
    - bear in mind that in cases of hypothermia, the bodies metabolism slows and casualties have been known to survive resuscitation after a full hour of not breathing/ nil cardiac output.

Notes:

1. *A Canadian study of avalanche related deaths during 1984 to 2005 found 65% due to asphyxiation, 24% due to major trauma, and 10% due to combined asphyxiation and major trauma (Boyd et al,* Canadian Medical Association Journal March 3, 2009 vol. 180 no. 5)

16 CHILDBIRTH

16.1 Introduction

The majority of births today occur in a controlled environment such as hospital labour wards and 'birth centres'.

Home births account for a small number of deliveries, but again, usually take place with immediate access to skilled medical attention.

In all cases, the best management of childbirth is via experienced medical and nursing care.

For the patroller, the major issue is that of unexpected, and therefore often premature, delivery.

Premature labour (less than 37 weeks gestation) occurs in about 1 in every 20 births with a high proportion of these being *precipitate labours* (i.e. less than 4 hours in duration).

Of these deliveries, the peri-natal *mortality rate* is significantly higher than the 1½ –1% mortality in the normal situation.

The specific reasons for this increased mortality are beyond the scope of this Manual.

This chapter reviews from the first-aid perspective:

- assessment of pregnancy and labour;
- basic management of delivery;
- post-natal care of mother and infant.

The first aid management described in this chapter refers only to ***normal, uncomplicated delivery***. Complicated births are common, but there is very little the patroller can do other than institute basic supportive care, administer Oxygen and analgesia, and get the mother to medical care urgently.

16.2 Pregnancy and labour

Normal *term* pregnancy occurs at any time from 37–42 weeks gestation. Normal *labour* is defined as the spontaneous vaginal delivery of the infant within 24 hours of the onset of regular, spontaneous contractions at or after 37 weeks gestation.

The onset of labour is often heralded by a *show*. This is a plug of mucus and/or blood passed vaginally.

The membranes may rupture (waters break) at any time during labour, though more commonly early in labour. This is manifested by a leakage (sometimes a gush) of usually clear fluid from the vagina. The fluid may be stained with meconium (foetal faeces), or be green or brown; this is frequently indicative of a distressed foetus.

Contractions are the result of regular coordinated tightening of the uterine muscle. These become increasingly frequent and of longer duration as the labour progresses and propel the baby down the birth canal. Labour occurs in three stages:

- the first stage, between the onset of contractions to full cervical dilatation (a period up to many hours);
- the second stage, or *transition*, from cervical dilatation to delivery (30 to 120 minutes, during which time the mother has an urge to push); and
- the third stage, being the delivery of the placenta or afterbirth (up to 30 minutes).

16.3 Management of delivery

Prepare as clean a 'field' as possible; use clean towels, sheets, etc, which should be draped over nearby furnishings and the mother's legs and abdomen if possible. Allow the mother to assume any position in which she is comfortable.

Resources desirable during labour are:

- Oxygen with nasal suction catheter;
- at least two clean (preferably sterile) pieces of cord, cloth, or tape, with which to tie the cord; and
- a pair of sterilised scissors.

If any are not available, compromise or improvise as closely as possible. Entonox is an effective analgesic for use during labour, should the mother require it.

It is preferable to wash down the entire groin area with antiseptic diluted in water.

At no stage should any person other than a doctor or qualified midwife perform a vaginal examination.

As the labour progresses:

- The top of the baby's head will slowly appear. A hand should be placed gently, but firmly, over the head to prevent it popping out with a sudden rush. Allow the head to come out gradually. The presentation of body parts other than the head is an emergency and warrants immediate medical intervention.
- After the head emerges, use the fingers to check for loops of umbilical cord around the baby's neck. If present, try to unloop the cord over the head, but only if this is easily done.
- If all else is well, the baby should emerge forthwith, umbilical cord attached. Occasionally it may help to pull gently on the baby's head, but if the rest of the body fails to emerge, it is again an emergency known as shoulder dystocia and requires expert intervention.
- Normal newborn infants do not require suctioning of the nose, mouth or pharynx after delivery. They clear their airway very effectively. If it is unlikely that meconium or blood has been inhaled, suction is rarely needed. However, if secretions appear to be obstructing the airway they can be gently and carefully cleared with a suction catheter. At this stage, ligate (tie off) the umbilical cord about 5 cm from the infant's abdomen by tying two (2) pieces of cord tightly about 5 cm apart. Cut the cord using the clean scissors between the two ties so one remains on the baby's end, with one on the placenta.
- Do not attempt to deliver the placenta. Pulling of the cord can turn the uterus inside out (uterine inversion), a serious problem that can lead to maternal shock. The placenta will usually deliver unaided.
- Gentle rubbing of the top of the uterus ('rubbing up') will assist it to contract and expel the placenta, and reduce bleeding. The top of the uterus may be felt as a globular mass just below the navel.
- Suckling by the infant from the mother's breast also encourages contraction of the uterus.

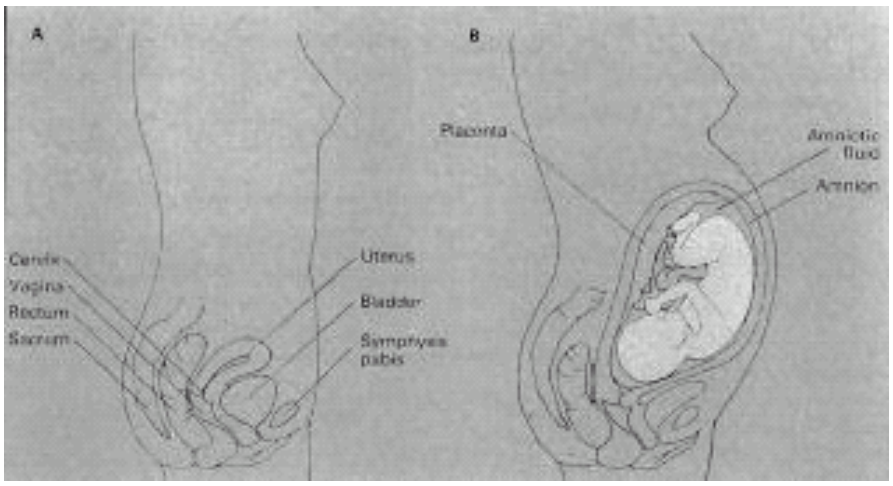

Figure 276 Childbirth: cross sectional anatomy

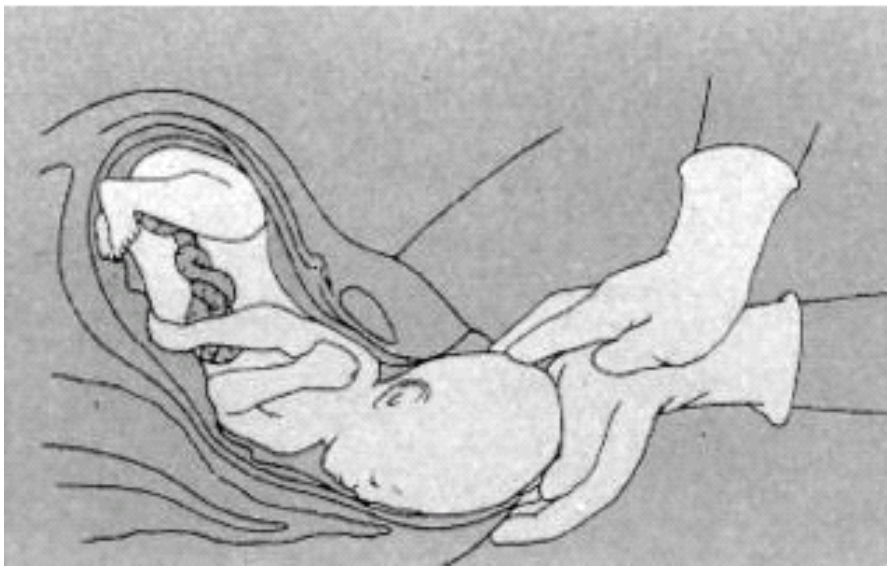

Figure 277 Childbirth: appearance of the head

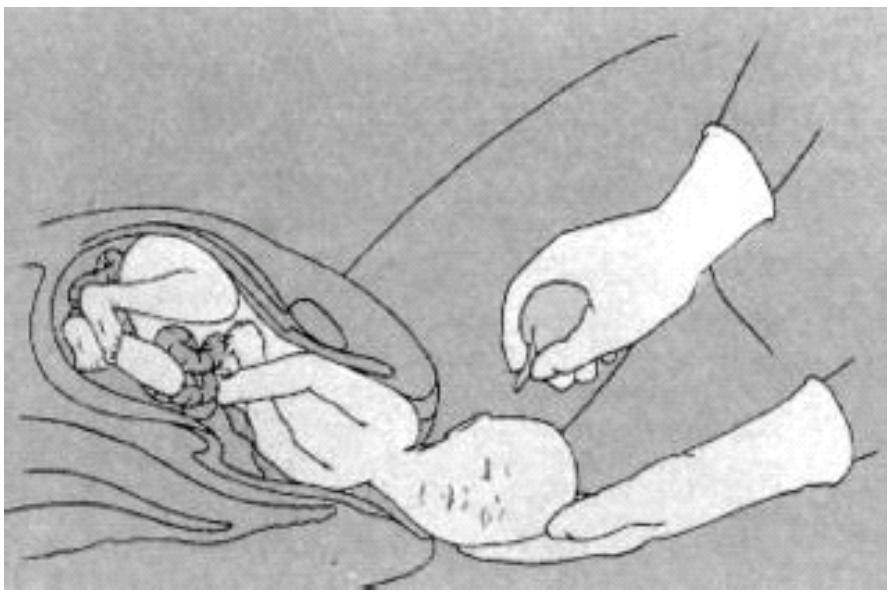

Figure 278 Childbirth: delivery of the head

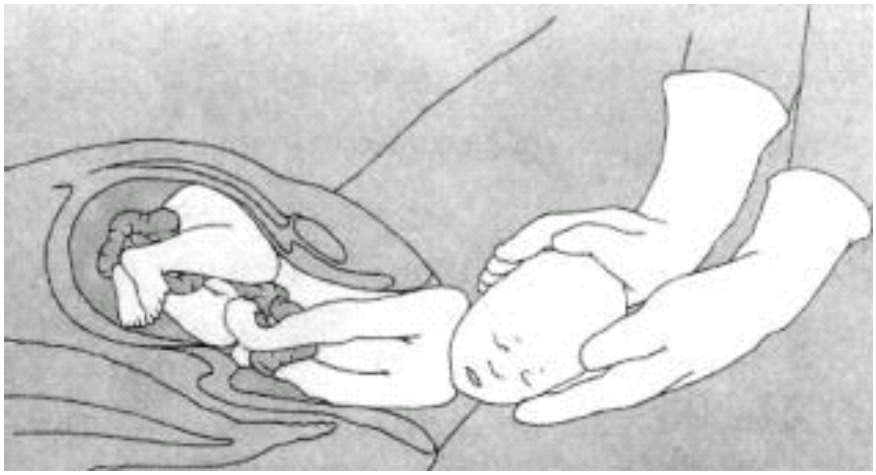

Figure 279 Childbirth: Progression of delivery

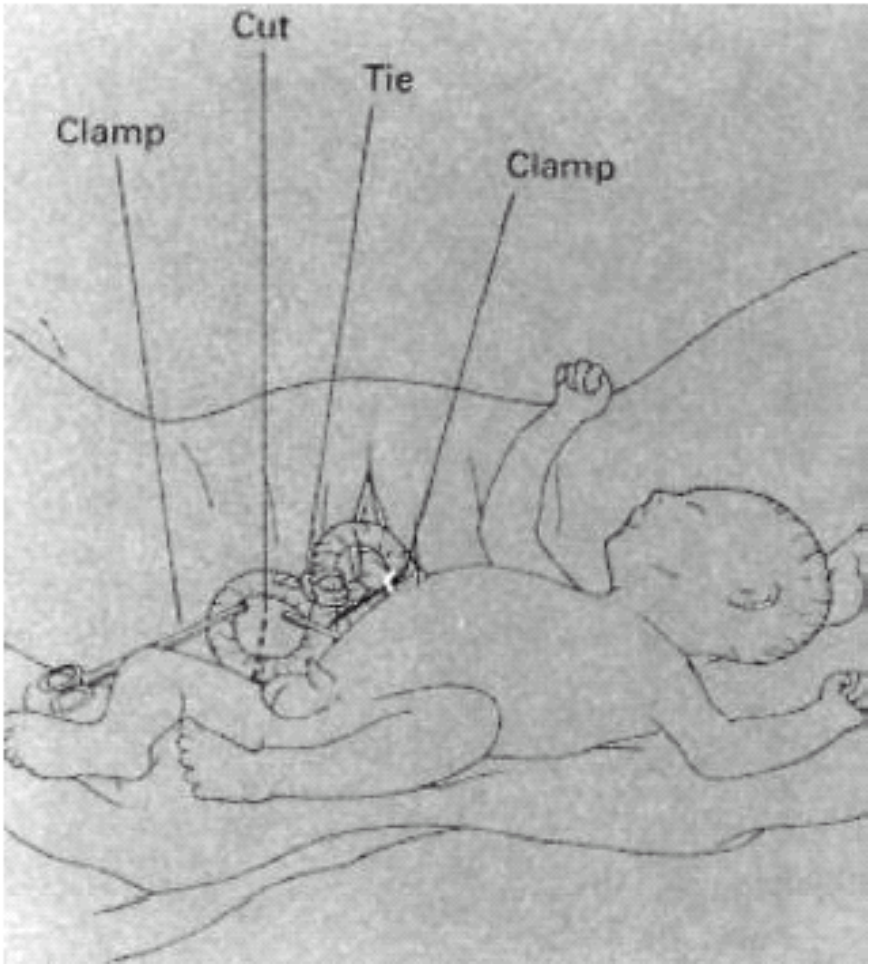

Figure 280 Childbirth: tying and clamping of the umbilical cord

16.4 Care after delivery

- Dry the baby gently and wrap it snugly as soon as possible to keep it warm. Hypothermia is a serious problem for newborns.
- The mother may well have sustained some tears in the vagina and these should not be interfered with; simply apply clean towels or large dressings gently to cover the area.

- Transport mother and baby to medical care urgently as both are likely to require further evaluation and treatment.
- Post-delivery bleeding, known as *post-partum haemorrhage* is a common complication evident by continued bleeding from the vagina after delivery. First aid management includes 'rubbing up' the uterus through the abdomen (as previously described) to keep the uterus firm and contracted. If this simple measure fails, ***help must be sought urgently***, as it is possible for the mother to bleed to death.
- Management for Shock should be commenced.

17 OHS & INFECTION CONTROL

17.1 OHS

Occupational Health and Safety (OHS) legislation in all States of Australia requires that employees of all types:

- be provided with safe conditions within which to work; and
- observe the OHS guidelines and procedures developed by their employer to provide a safe workplace.

In the Ski Patrol context, the most significant risks in terms of potential consequences and frequency of incidence are:

- participation in snowsports;
- manual handling of equipment and casualties;
- slips, trips, and falls within premises; and
- infections from first aid delivery.

Lesser risks, depending on the specific Ski Patrol tasks being undertaken, include:

- being hit by moving objects;
- falls from a height;
- chemical hazards;
- noise;
- psychological (fatigue, violence, bullying);
- outdoor exposure (UV, cold, wind); and
- hitting moving objects.

Those items underlined above comprise the top 5 causes of injuries to workers across all industries.

This section introduces the concepts of hazards and risk management as relevant to the Ski Patrol context, and discusses physical hazards.

Later sections in this chapter focus on the Infection Control elements of Ski Patrol OHS.

17.1.1 SKI PATROL WORKPLACE HAZARDS

In the Ski Patrol workplace, it is first important to understand which groups of workers are at greatest risk – since these groups are heavily represented within the Ski Patrol context:

- young workers under the age of 25;
- new workers including those:
    - entering the workforce for the first time;
    - re-entering the workplace;
    - employed for less than 12 months;
    - transferring to a new job or role; and
- male employees.

The types of hazards typical in workplaces and present within most Ski Patrol contexts include:

- physical e.g. noise, radiation, light, vibration;

- chemical e.g. poisons, dusts;
- biological e.g. viruses, plants, parasites;
- mechanical/electrical e.g. slips, trips and falls, tools, electrical equipment; and
- psychological e.g. fatigue, violence, bullying.

A ski patroller needs to be aware of, and be able to identify, these hazards so that the potential of an incident can be avoided.

Specific workplace hazards that a ski patroller may experience include:

- manual handling e.g. pushing, pulling, carrying, lifting equipment and casualties;
- the work environment e.g. floor surfaces being slippery (especially in ski boots), noise, extremes of temperature;
- machinery (e.g. snow grooming, snow making, lifts);
- heat e.g. burns and scalds in first aid rooms, workshops, etc.;
- electricity;
- harassment e.g. bullying and/or violence;
- hazardous substances e.g. chemicals, fumes from machinery;
- biological hazards and biological wastes (refer to Infection Control sections below);
- confined spaces; and
- skin penetrating injuries e.g. knife or syringe injuries.

Figure 281 Ski patrol workplace hazards: manual handling loaded Akja – use correct technique

Figure 282 Ski patrol workplace hazards: manual handling fencing – use correct technique

17.1.2 INDENTIFYING AND MANAGING HAZARDS

Hazards in the workplace occur in different context and in different ways over time. Ski patrollers need to be aware at all times of the presence of hazards and consider how to manage them.

Hazard identification may take place through:

- workplace inspections;
- consultation between employer and employee groups, or with supervisors;
- monitoring of injury and illness records;
- recording complaints; and
- observation by all employees and supervisors of the workplace and the behaviour and safety attitude of those within it.

In order of effectiveness from most to least effective, hazards may be dealt with by:

- eliminating the hazard – eliminate the need for the hazardous activity or element (for example, fence off dangerous cornice area to exclude personnel, rather than seek to break down a large cornice);
- changing the equipment or materials being used for a task to reduce or eliminate the hazard (for example, the use of roll-on / roll-off trailers for skidoo transport of loaded akjas);
- changing work methods to reduce the hazard (for example avoid lifting sleds into trailers when heavily loaded); and
- use personal protection equipment (PPE) to provide improved protection of the employee when they are exposed to an otherwise unavoidable hazard (for example, the wearing of gloves when treating casualties, sunscreen, and eyewear).

In considering how best to manage risks involved in any task, those undertaking the task and their supervisors should:

- Identify the hazard – what are the risks and what is causing them?
- Assess the risk – how significant is the risk, and how necessary are each of the risk elements of the task?

- Eliminate or control the risk – can the risk be eliminated from the task altogether, or must it be modified to reduce the severity or likelihood of the risk creating a hazardous situation?
- Monitor and improve the workplace, so that ongoing risk management and hazard assessment is adopted by all staff.

17.1.3 OHS RESPONSIBILITIES

The employer (typically the resort in a ski patroller context) has responsibilities to:

- provide a safe working environment;
- provide a safe system of work;
- provide proper training and information;
- identify hazards, assess the risks and eliminate or control the risks;
- provide supervision;
- supply personal protective equipment and clothing; and
- consult with employees about OHS matters.

Ski patrollers have responsibilities to:

- take responsibility for their own safety;
- know what to look for when entering a new or different workplace;
- know what questions to ask about the job;
- report any health and safety concerns to their supervisor; and
- follow all safety procedures nominated by their employer.

Each ski patroller should know the answers to these questions, and ask their supervisor if the answers are not known:

- What are the dangers of my job?
- What are the hazards?
- Should I have any job safety training?
- Do I need any personal protective equipment (PPE)?
- Should I be trained in how to use my PPE?
- Where are the first aid facilities?
- What do I do if I get injured?
- In the premises where I work, where are the fire extinguishers, the emergency exits, how will I know if there is an emergency, and what should I do in an emergency?
- Who do go to in the workplace if I have a health or safety question?

17.2 Infection Control

Infection is the spread of disease caused by the transfer of micro-organisms ('germs', 'bugs', 'microbes') from one host to another. Not all micro-organisms cause disease. Those that do are called pathogens.

17.2.1 CLASSIFICATION OF MICRO-ORGANISMS

The major groups are the:

- viruses ;
- bacteria;

- fungi; and
- parasites.

Viruses are the smallest, most common, and hardest to treat with drugs. It is most important to prevent the spread of viruses, especially in the case of serious or life-threatening infections.

The next smallest and most frequent are the bacteria, which can be effectively treated with antibiotics and hence pose less threat, but are still very important to prevent as some have developed resistant strains.

The fungi and parasites, in the first aid context, are less common and pose little problem; in any case, spread is prevented by the measures to be outlined in this chapter.

17.2.2 MODES OF TRANSMISSION

These vary with different infections and include the following:

- contact of blood, body fluids, or substances with damaged skin, wounds, or intact mucous membranes (this poses the greatest threat in casualty care in first aid situations);
- direct contact;
- inhalation of droplets; and
- ingestion.

17.2.3 UNIVERSAL PRECAUTIONS

Laws have been passed outlining the procedures and standards of care to prevent the infection of health care workers, casualties, and the public during casualty management. All health care facilities, employers, and workers must comply or face penalties.

These procedures and standards are based largely on a set of procedures called Universal Precautions, intended to prevent the infection of health care workers, by the blood borne viruses of human immunodeficiency (HIV), hepatitis B (HBV), and hepatitis C (HCV). Australia has broadened the definition of which fluids were considered infectious to include all blood, body fluids and body substances and to apply this principle to all casualties regardless of infectious status.

All casualties must be considered as potentially infectious and precautions must be adopted in all casualties regardless of perceived risk or lack thereof.

Universal precautions are based on the principles of hand washing and hand care, the use of protective barriers and apparel, and the safe handling and disposal of “sharps” and contaminated waste.

17.2.3.1 Hand washing and hand care

These are considered the most important measures in infection control. Intact skin with no cuts, abrasions, or lesions provides a natural defence against infection. Despite this gloves must always be worn when handling blood or body substances. Precautions to be followed are:

- gloves are to be worn when handling blood and body substances;
- occlusive, water-resistant dressings on exposed skin lesions, are to be changed four (4) hourly or whenever soiled;
- hands must be washed immediately if contaminated by blood or body substances;
- hands must be washed with soap and running water with a rubbing action to all surfaces and then dried;

- hands must be washed before and after all casualty care, between each casualty, and after the removal of gloves; and
- blood and body fluids must not be poured down hand basins.

Figure 283 Universal precautions: always wear gloves when exposed to body substances

An alcoholic chlorinated handrub ('Hibicol' or 'Microshield Handrub') will suffice where no washing facilities exist. All hand surfaces must be rubbed as in washing. A small refillable container can be carried in the patroller's equipment for use on the snow.

17.2.3.2 Protective barriers and apparel

These include gloves, aprons (or gowns), masks, and protective eyewear. These items should be worn when it is considered that there will be exposure to blood or body substances but only the appropriate items used as required.

GLOVES

- Gloves must always be worn if the hands are likely to be exposed to blood or body substances, damaged skin, intact mucous membranes, or if organisms on the carer's hands might contaminate the casualty. Non-latex gloves are recommended due to possible allergic reaction to wearing latex gloves.
- Disposable gloves must be discarded after use.
- Hands must be washed before and after use.
- Gloves are to be changed between casualties and ideally to treat different areas on the same casualty.
- Gloves are to be changed if torn or punctured.
- Gloves worn for handling contaminated items or surfaces must be disposed of correctly.

- Sterile gloves are to be worn for handling normally sterile tissues. Antiseptic handrub rubbed on clean gloves would suffice where sterile gloves are not available in emergencies.
- General-purpose rubber utility (household) gloves are to be worn for cleaning, and for handling contaminated waste and chemicals. These can be reused and should be washed in detergent after use; discard immediately when perished or damaged.
- Disposable gloves should comply with the relevant standard AS/NZS 4011.

APRONS AND GOWNS

Waterproof aprons or gowns should be worn when:

- splashing is likely or heavy contamination expected; or
- copious bleeding or wound drainage is present.

Aprons and gowns should be discarded after use and before treating other casualties. Contaminated clothing should be removed as soon as possible and hands and any other contaminated areas washed.

MASKS

Masks should be worn where spraying or splashing onto the face or contamination by breathed air is likely. These should:

- cover the nose and mouth with no gaps at the sides;
- not be touched by hand while being worn;
- be removed by touching only the loops or strings; and
- be disposed of or cleaned and sterilised after use, and before treating other casualties.

PROTECTIVE EYEWEAR

This should be worn where there is risk of spray or splash into the eyes. It should be:

- close fitting;
- unbreakable; and
- disposable, or reusable after cleaning and disinfection.

Polycarbonate goggles best meet these needs. These must be cleaned properly after contamination if intended to be reused, otherwise they must be disposed of.

17.2.3.3 Sharps

These are objects capable of penetrating body tissue that are (or may be) contaminated with blood or body substances. Needles, scissors and other cutting instruments, glass, foreign bodies, spicules of bone, tooth fragments, and the like may all be encountered in first aid treatment. The principles involved in handling and disposal are:

- sharps must be handled with care to avoid injury;
- sharps must be handled with care using safeguards (if available) such as using trays rather than hands to transfer;
- needlestick injuries should be avoided by not directly handling or resheathing needles, using instruments to detach unsheathed needles from syringes and discarding directly into a sharps container;
- sharps containers should be rigid, puncture and leakproof, and easily identified by a distinct yellow colour and circular markings; and
- sharps containers should be well sealed and not overfilled.

17.2.3.4 Contaminated waste

This includes contaminated sharps, dressings, body organs or parts, blood and body fluids, microbiological and pathological waste, and disposable linen, or apparel contaminated by any of these. Handling precautions are:

- contaminated waste must be bagged and contained at the source of generation where possible;
- sharps must be disposed of in sharps containers (see above);
- contaminated waste bags and containers should be yellow and bear the multi-circle symbol;
- bags should be tied securely and not overfilled;
- gloves should be worn;
- bags should be held away from the body to avoid soiling; and
- blood and containers of body fluids (suction bags, syringes) should be sealed and placed, unemptied, into contaminated waste bags.

Ultimate disposal of contaminated waste is beyond the capacity of Ski Patrols and should be negotiated with the doctor, ambulance service, or local health authority, all of whom will have arrangements to suit disposal needs.

Figure 284 Contaminated Waste: dispose of waste only in approved receptacles and clean contaminated equipment correctly before re-use

17.2.4 SPECIFIC EQUIPMENT SITUATIONS

17.2.4.1 Analgesic and other systems

- ***Entonox:*** a single use filter placed in the circuit between the mouthpiece and the circuit prevents the circuit from contamination. Only the filter and mouthpiece need be discarded. If no filter is used the whole circuit must be cleaned and disinfected.

- ***Penthrane Inhalers*** must be discarded after single casualty use. Do not re-use.
- ***Low pressure oxygen therapy:*** the Hudson mask and tubing should be discarded after each casualty. Masks and tubing are cheaply replaced; cleaning and disinfection are thus avoided.
- ***Resuscitation:*** devices used for CPR should prevent direct mouth-to-mouth contact between patroller and casualty. These should be either discarded or cleaned and disinfected after use.
- ***Core Rewarmer:*** the core rewarmer and all tubing and mouthpieces must be cleaned and disinfected after use. If possible a single-use mouthpiece and filter should be used and discarded after use.
- ***Air Splint:*** small hand pumps should be used where air splints are shared between patrollers; otherwise, a patroller may inflate the splint directly by mouth provided a patroller's personal one-way valve and hose are used.

17.2.5 PROCESSING EQUIPMENT AND INSTRUMENTS

Critical items are those that enter sterile tissue or the vascular system and must be sterile; e.g. needles or surgical instruments. Cleaning precedes sterilisation.

Semi-critical items are items that have contact with mucous membranes or non-intact skin must be disinfected (or can be sterilised if expedient). Cleaning precedes disinfection.

Non-critical items are items in contact with intact skin but not mucous membranes and must be cleaned.

17.2.5.1 Cleaning

This is achieved by the removal of soil and most micro-organisms by washing in water with some physical action and the use of a detergent and/or proteolytic enzyme; e.g. scrubbing or ultrasound and the use of 'Medizyme'.

17.2.5.2 Disinfection

Clean all items prior to disinfection. Thereafter disinfection may be carried out by either thermal or chemical means. Thermal is the preferred method. It entails the use of heat and water for a sufficiently long period to kill or inactivate most organisms that cause infections in a Hot Water Disinfector. Minimum surface temperature and time relationships are:

2 minutes at 80^{o} C
10 minutes at 75^{o} C
15 minutes at 70^{o} C

Table 13 Infection control: Minimum surface temperature and time relationships

Chemical disinfection may be used where thermal disinfection is not possible. However, the only chemical approved for disinfection ***is very dangerous if used improperly. Its use requires specialised equipment and training, and must not be undertaken by anyone not suitably trained, or without the appropriate facilities.***

17.2.5.3 Sterilisation

The only practical method for a Ski Patrol is by autoclave. Although most will not have this facility it may be available from the doctor's surgery or a nearby hospital. The autoclave subjects the contents to steam at controlled pressure and temperature for an appropriate time. Not all materials are suitable for this process. Prepacked disposable sterile materials are available from surgical supply houses, and use of these is encouraged.

17.2.6 NON-CLINICAL ASPECTS

17.2.6.1 Cleaning

- Mops, cloths, and brushes should be clean and in good working order;
- neutral detergent is recommended for general purpose cleaning;
- work surfaces should be made from stainless steel; surfaces should be cleaned regularly and as soon as possible if soiling or spillage occurs; and
- disinfectants are not recommended for general cleaning.

17.2.6.2 Blood spills

- Wear protective apparel and gloves;
- confine and contain the spill;
- remove the bulk of the spill by soaking up with absorbent material, which must be disposed of in a contaminated waste bag;
- clean the spill site with detergent solution; and
- wipe the site with disposable towels soaked in a solution of 1% available chlorine such as household bleach or liquid swimming pool chlorine appropriately diluted.

17.2.7 PROTOCOLS

Each Patrol should put in place protocols for dealing with special situations. These should be available and familiar to all personnel so that risks and anxieties are minimised. This chapter should provide a sufficient framework for the formulation of protocols, which should include:

- hand washing, hand care, and dressings;
- management of skin contamination and needle stick;
- use of protective apparel;
- handling and disposal of contaminated waste;
- cleaning, disinfection and sterilisation; and
- blood spills.

17.2.8 INFECTION CONTROL COMMITTEE

Each Patrol should have an infection control committee, which continues to review all aspects of infection control relevant to the organisation. This would include quality control, possible improvements in any area and the education and assessment of the skills of all members. An infection control officer should be appointed to implement and manage these aspects.

18 PRACTICAL APPLICATIONS OF KNOTS

18.1 Introduction

This chapter describes the application of commonly used knots useful for the application of slings and for basic rope work relevant to Australian Ski Patrols.

18.2 Rope skills

18.2.1 GENERAL

Within the emergency care industry many varied types and sizes of roping equipment are used when accessing or retrieving casualties and equipment, and also when supporting or restraining injuries and the injured.

When using any of these systems or parts of systems a ski patroller must have completed training and assessment in order to be competent to use each particular part.

Patrollers operate most often in extreme climatic conditions and must recognise the additional hazards that snow, water, and ice have on the use of roping systems. ASPA recommends that a significant part of the assessment process be carried out in winter conditions.

This section is in no way intended to replace or supplement an appropriate rescue roping course nor is it a qualification in any sort of rescue roping.

18.2.2 ROPES, TAPES, LASHINGS AND HARNESSES

There are a number of different types, sizes and materials used in Emergency Care Roping. Whenever a patroller or casualty are attached to any of these devices or materials, ***the system is being used for life support and may become life threatening*** if all due care is not taken.

ASPA recommends that all Ropes, Tapes, Harnesses and other supporting hardware comply with relevant Australian Standards particularly AS:4142 and AS:1891. These standards give guidance on the minimum requirements for the standard of selection, care, maintenance, and use.

There are two types of rope used:

- **Natural fibres** e.g. manilla, hemp, and sisal. These are not energy absorbing. They lose strength when they are wet.
- **Synthetic fibres** e.g. nylon, perlon, and polypropylene. These are energy absorbing. Polypropylene must be stabilised against deterioration caused by sunlight.

Ropes can be constructed as *laid* or *Kernmantle* (with a continuous inner core). A laid rope has a slightly lower breaking strain than a Kernmantle rope.

Synthetic ropes are generally two to three times stronger than natural fibre ropes of similar size.

As a guide ropes used for life support must have a minimum diameter of:

- 11mm for synthetic Kernmantle ropes used for raising or lowering people;
- 22mm for non-Kernmantle ropes used for raising or lowering people;
- 9mm for synthetic Kernmantle ropes used for safety lines; and
- 16mm for non-Kernmantle ropes used for safety lines;

Reduction of strength of ropes may be due to:

- abrasion;

- sunlight;
- wear;
- size;
- physical damage; and
- a sharp bend or knot, which may reduce the strength of a rope by up to fifty percent.

To take care of ropes:

- dry out wet ropes before storage;
- do not walk on ropes;
- keep away from grit and dirt;
- do not allow smoking within 5 metres (burning ash will damage the rope);
- keep out of sunlight where possible;
- protect from abrasion by sharp objects;
- replace a rope if damaged or worn; and
- keep away from paint, petroleum products, solvents, etc.

18.2.3 KNOT TYING

Patrollers use knots as part of casualty management every day, and must be capable of tying any of the knots described below, under any of the conditions likely to occur.

All knots affect the working strength of the rope, some more so than others. A patroller must be able to tie the knots correctly and efficiently using just the right number and type, to retain the maximum working strength of the ropes used.

As a general rule knots used by patrollers should be:

- easy to tie;
- easy to untie;
- easy to recognise in adverse conditions e.g. at night or in a white out; and
- provide maximum strength retention when tied, without severely affecting the final working strength of the rope.

In describing the tying of knots, the term ‘standing end’ is the long end, and the term ‘running end’ is the short end.

18.2.3.1 Single fisherman’s knot or stopper knot

The stopper knot is used for making a running knot onto another rope. It is a very handy knot to ‘back up’ other knots. Two tied in separate rope running ends can create a loop using a Single Fisherman’s knot. It is the first step of a double fisherman’s knot (refer below for tying).

Figure 285 Single Fisherman’s Loop using two stopper knots

18.2.3.2 Double fisherman's knot and loop

This knot is used to join two ropes of equal diameter. It may be used to make a loop of rope to form a Prussic loop. To tie:

- coil the running end of one rope twice around a second rope, and pass it back through the inside of the coils;
- repeat the procedure for the other running end, coiling this time around the first rope;
- pull on all four ends to cinch them snugly against each end, leaving the remaining tails about 7.5 cm long.

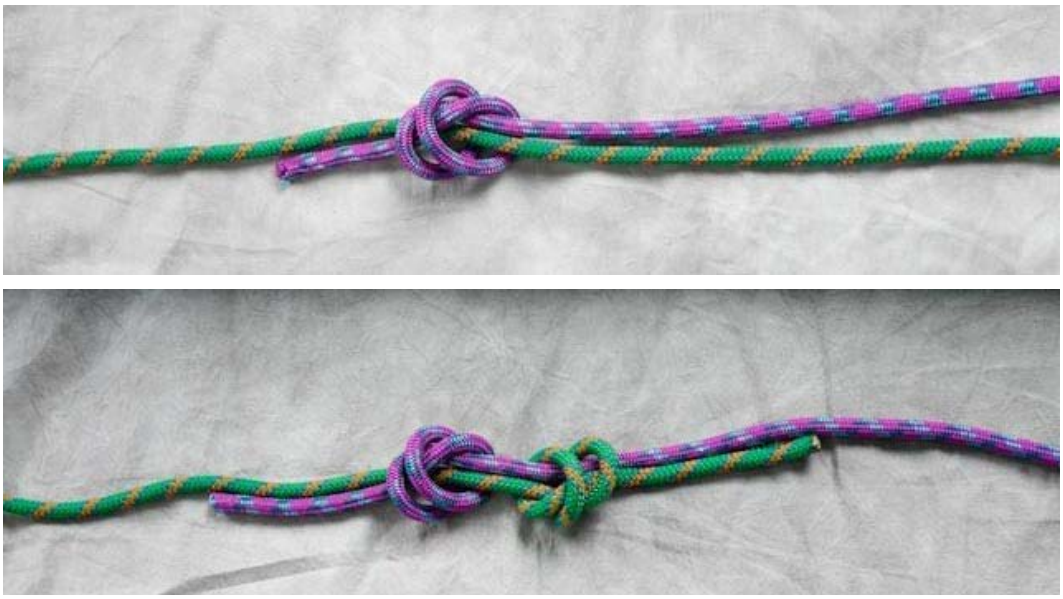

Figure 286 Double Fisherman's knot and loop

18.2.3.3 Clove hitch

This is used to secure ropes to poles, trees, stretcher handles or similar objects. It is also used in making a collar and cuff sling. This knot can untie unexpectedly and must be backed up with a stopper knot when used to secure a rope to an object.

To make a clove hitch correctly, make a loop around the pole so that the running end crosses over the standing end. Pass the running end around the pole a second time in the same direction as previously but pass the end through the loop made by crossing over the end as in the diagrams.

A second method applicable in making a collar and cuff sling or securing to a pole for hazard fencing begins by forming two loops. Reverse the position of the loops then slip the knot over the wrist, pole or other object to which the rope or bandage is to be attached.

Figure 287 Clove hitch onto a continuous pole

Figure 288 Clove hitch onto a pole or for a collar and cuff sling

18.2.3.4 Figure 8 knot or loop

This knot is the basic knot used for any life support anchor. It is tied in a single length of rope, and forms the first part of the rethreaded figure 8.

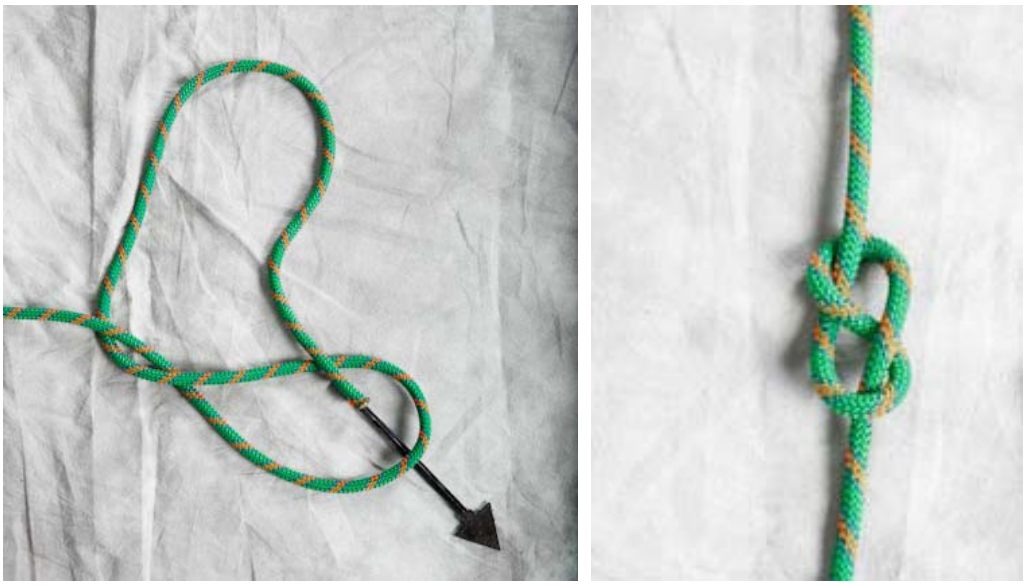

Figure 289 Figure 8 knot

18.2.3.5 Rethreaded figure 8 knot

This is also known as a ‘figure 8 follow-through’ or ‘Flemish bend’. The knot can be used for tying a rope around an object. It is especially useful when tying around large objects e.g. buildings or rock outcrops. To tie:

- tie a single figure 8 in the rope;
- pass the running end of the rope around the object, then retrace the original figure 8 by following the rope back through the knot; then
- tightly cinch all four strands of rope exiting the knot, and secure with a stopper knot.

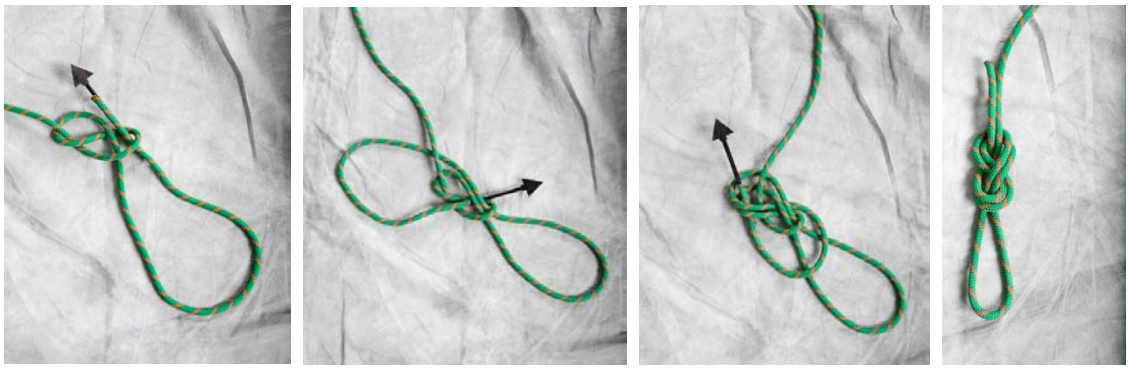

Figure 290 Rethreaded figure 8 knot

Figure 291 Rethreaded figure 8 knot – attachment to harness, with stopper knot

18.2.3.6 Figure 8 “on the bight”

This is the most commonly used knot in life support roping. It is used when attaching a karabiner to an anchor, for dropping the rope over a bollard type anchor, or joining two ropes together with a karabiner. Tie a figure 8 in a bight of rope, leaving a loop for attachment.

Figure 292 Figure 8 “on the bight”

18.2.3.7 Prussic knot

This knot is used to grip objects such as in the emergency ascent of a rope. It is formed using a continuous loop of rope. The Prussic knot must use cord of about 1/2 the diameter of the rope being ascended.

To tie:

- use a cord sling and tie a girth hitch once around the rope to be ascended;
- pass the loop of the sling back through the centre of the original hitch 3 or 4 more times; and
- load the loop coming out of the Prussic to check that it holds, and add more wraps if not.

Figure 293 Prussic knot

18.2.3.8 Alpine butterfly knot

This is a very handy knot and very easy to learn. It is used extensively by emergency services to carry out various functions:

- as an anchor point above a hole;

- to form a loop within a length of rope;
- to isolate a damaged section within a length of rope from applied load;
- as a point to connect a rope re-direction; and
- as part of an anchor system.

To tie (method 1):

- make a loop in the rope and twist a full revolution, so that the rope makes the shape of an eight;
- fold the top of the eight around the bottom of the eight and out through the lower opening in the eight; and
- cinch by pulling tight on both strands.

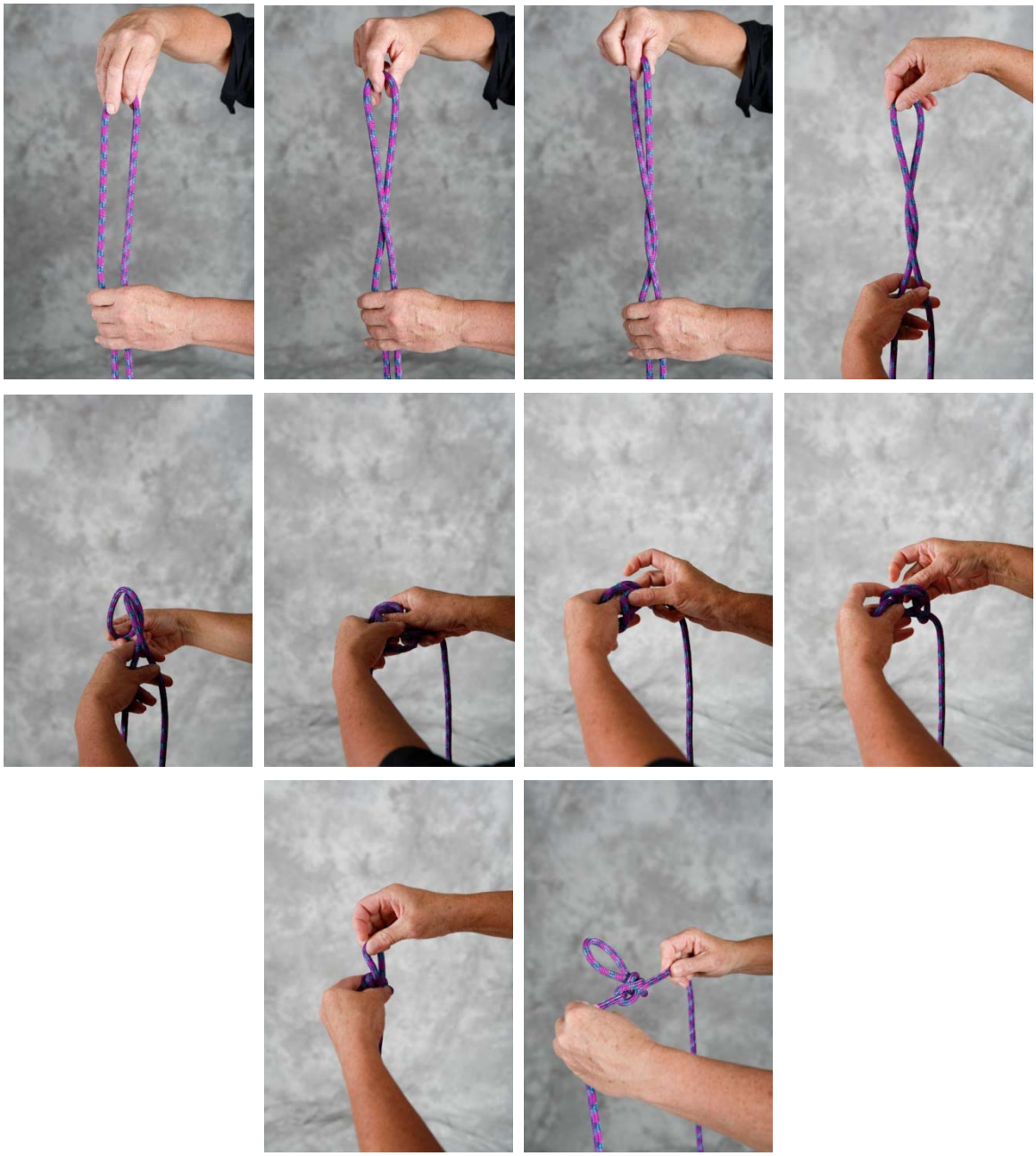

Figure 294 Alpine butterfly knot – method 1

To tie (method 2):

- start with the standing end of the rope laid across the palm of your hand;
- wrap the running end around behind your fingers and pass over the palm towards the wrist;
- repeat, with the rope closer to the wrist;
- take the middle rope section from the bottom edge of your hand (created by the first wrap above), lift and create a loop and slack;
- push the loop along the face of your palm under the other strands of rope laying across the palm;
- pull the loop through towards your fingers; and
- cinch by pulling tight on both strands.

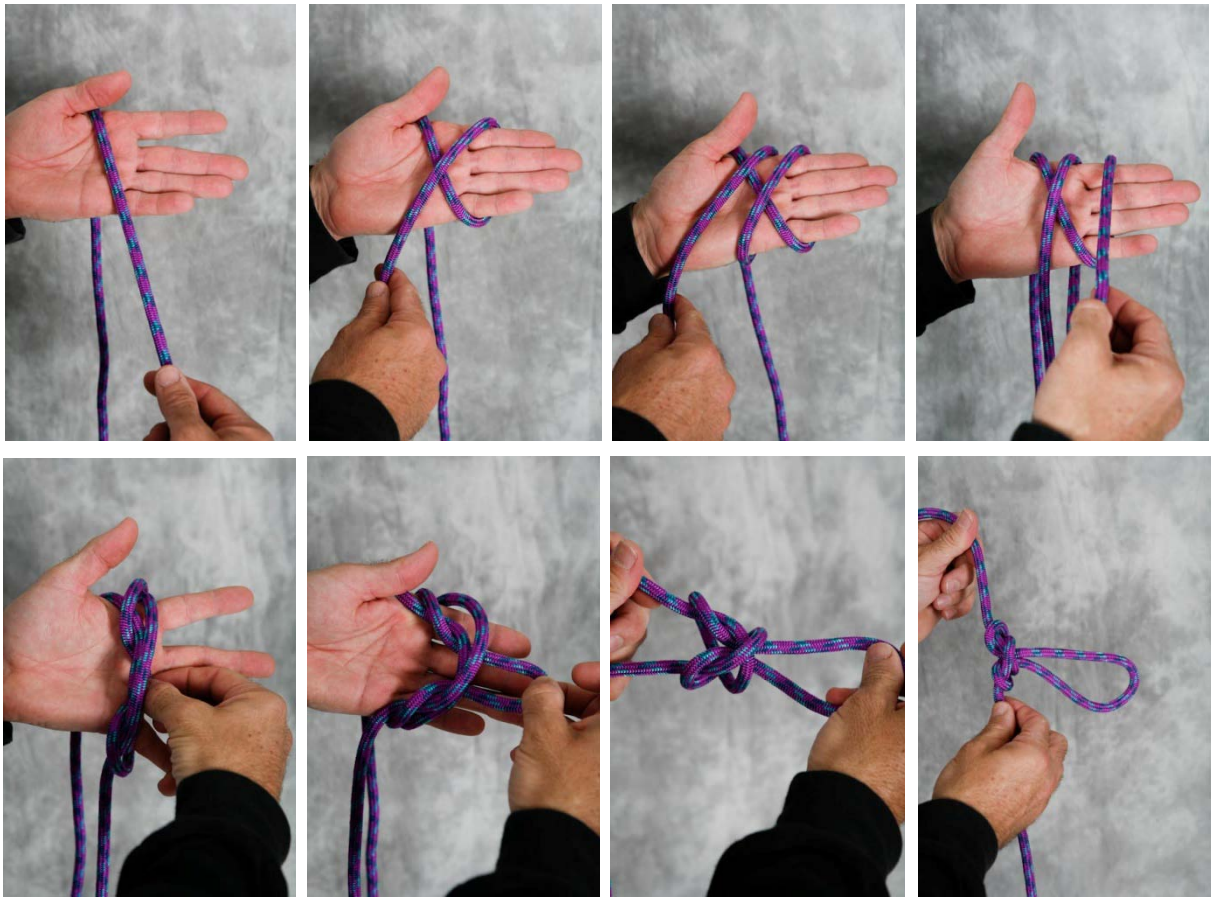

Figure 295 Alpine butterfly knot – method 2

18.2.3.9 Tape knot

This knot is also known as a Ring Bend or Water Knot. It is the only knot to be used for joining any flat tape tubes or webbing. The knot may slip over time, and should be backed up by a stopper knot on each tape strand and inspected to check the consistent length of tails before each use.

To tie:

- make a single overhand knot in one end of the tape; and
- match the other end to the first and trace it back through the original overhand knot, so that the tails exit from opposite sides and are about 7.5 cm long.

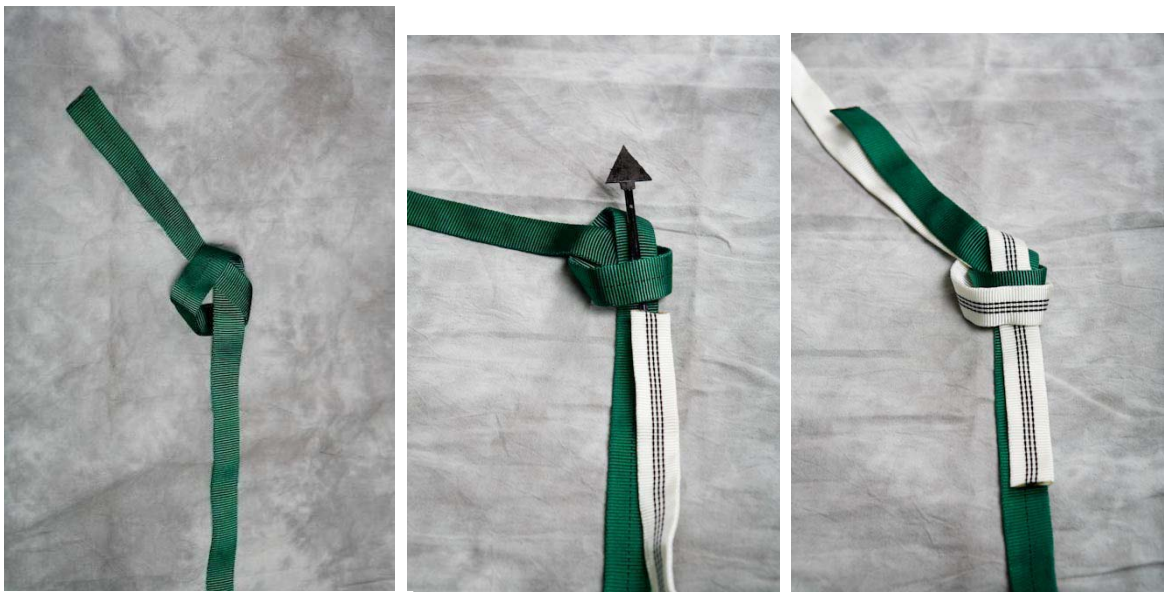

Figure 296 Tape knot (Ring Bend, Water Knot)

18.2.3.10 Reef knot

This knot is used to join two ropes of equal thickness. It is used for tying off bandages and slings, and for joining non-life support ropes and lashings.

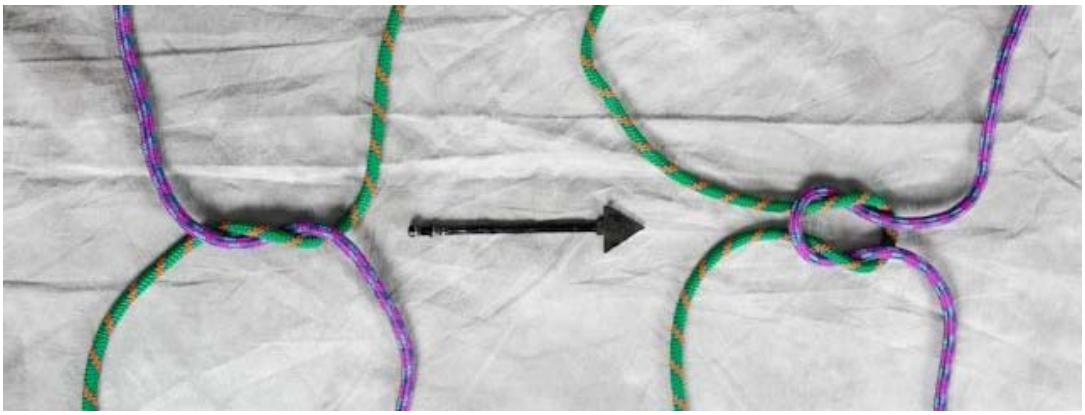

Figure 297 Reef knot

19 GLOSSARY

The glossary provides definitions of terms which are not otherwise defined within the text. For further definitions in context, refer to the Index and look up the relevant terms within the text.

Abduction	To move limb away from body, elevate
Adducted	Drawn towards mid-line of body
Anaesthesia	Absent or altered sensation
Anaphylactic shock	Shock due to life threatening allergic reaction
Anatomy	Study of the structure of the body
Aneurysm	Weakness in wall of blood vessel, causing it to bulge
Aorta	Main artery supplying the body from the heart
Arachnoid	Middle layer of protective tissue surrounding the brain
Areolar tissue	Tissue which provides packing around organs and protects blood vessels, nerves and muscles
Arrhythmia	Irregularity of the heart rhythm
Arteries	High pressure blood vessels which carry blood away from the heart
Atheroma	Deposition of cholesterol and calcium on the inner wall of artery leading to narrowing and blockage)
Atria	Holding chambers of the heart
Autonomic	Control by involuntary nervous system
Avulsion fracture	A fracture where a piece of bone is torn off by attached soft tissue
Bilateral	Affecting both sides of body
Cancellous bone	Spongy internal bone tissue
Cardiac output	Normally around 5 litres per minute
Cardiovascular system	Heart and blood vessels
Carpals	Bones forming the wrist and base of hand
Cartilage	Firm and sturdy connective tissue
Cell	The basic functional and structural building block of the body
Cerebral contusion	Damage to brain which causes swelling of brain tissue and may be associated with bleeding
Clavicle	The collarbone
Comminuted fracture	Bone broken into more than two pieces
Compact bone	Hard bone layers which lie immediately under the periosteum
Complicated fracture	Fracture with associated damage to adjacent tissues, organs, nerves, blood vessels, etc
Compound fracture	Fracture with an associated wound site
Concussion	Temporary loss of brain function generally caused by a blow to the head
Convergent gaze	Eyes focus on nearby object; cross-eyed
Cranium	Braincase portion of skull structure

Crepitus	Grating sound at the ends of fractured bone
Cyanosis	Blue coloured skin due to presence of deoxygenated blood
Diastole	Relaxation phase of the heart
Diastolic pressure	Blood pressure during relaxation phase of cardiac cycle
Dilatation	Expansion of blood vessels, etc
Dilation	Widening of pupils of the eyes; also used in reference to expansion of blood vessels, etc
Dislocation	Displacement of bone ends in a joint
Dura	Outer layer of protective tissue surrounding the brain
Eclampsia	A disease occurring in the latter half of pregnancy or sometimes just after birth, with acute elevation of blood pressure (and other symptoms) plus convulsions or coma; see also Preeclampsia
Embolus	Blood clot, air, fat or foreign object, moving in a blood vessel from a different site
Endothelium	Inner lining of blood vessel
Femur	Thigh bone, forms the upper leg and is the longest bone on body
Fibula	Smaller of the two lower leg bones, the lower end forms the prominence on the outside of ankle
Fracture	Any break in the continuity of a bone
Grasp reflex	Reflex of grasping an object when the palm or inside of the fingers is touched
Greenstick fracture	Bone is kinked or bent, but not separated
Haemoglobin	Iron containing molecule in red blood cells with the ability to bond to oxygen molecules
Haemophilia	Male disease where blood fails to clot
Hemarthrosis	Blood in joint
Hematoma	Collection of blood as a result of internal bleeding
Humerus	The upper-arm bone
Hypercapnia	Raised levels of carbon dioxide in the blood
Hypovolaemic shock	Shock due to rapid blood loss
Impacted bone	Bone ends at a fracture site driven into one another
Ligaments	Connect bone to bone
Lymphatic system	Cell and tissue fluid circulation system
Marrow	Network of blood vessels, connective tissue, fat cells and blood cells in the hollow bone cavity
Metacarpals	Bones forming the midsection of the hand
Nerve palsy	Numbness, tingling or paralysis due to nerve tissue damage
Neurogenic shock	Shock caused by dilatation of blood vessels due to loss of sympathetic nerve control (as caused by spinal injury)
Oblique fracture	Fracture which occurs at an angle to the long axis of a bone
Palpable	Can be felt
Patella	The kneecap

Perfusion	Circulation of blood and nutrients through an organ or tissue
Pericardium	Membrane surrounding the heart
Periosteum	Thin fibrous membrane which forms the outer layer of bone
Peritoneum	Double membrane lining the abdominal organs and the cavity of abdomen
Phalanges	Bones forming the fingers and toes
Photophobia	Dislike of light
Physiology	Study of the function of the body
Pia	Inner most covering of protective tissue surrounding the brain
Pleura	Double layered sac surrounding the lungs and lining the chest cavity
Preeclampsia	A disease occurring in the latter half of pregnancy or sometimes just after birth, with acute elevation of blood pressure (and other symptoms) without convulsions or coma; see also Eclampsia
Pulmonary circulation	The circuit of arteries and veins which takes deoxygenated blood to the lungs for reoxygenation and returns the oxygenated blood to the heart for distribution throughout the body
Pulse	Pressure wave in arteries caused by contraction of heart
Radius	One of two forearm bones, on the thumb side of lower arm
Referred pain	Pain felt remote from the injury site due to associated nerve injury
Semilunar valve	One way valves in veins
Shock	A state in which there is a widespread serious reduction in tissue perfusion
Spiral fracture	Fracture twists around bone
Sprain	Partial or complete tearing or stretching of joint ligaments
Sternum	Breast bone
Strain	Overstretched or torn muscle or muscle group
Synovial fluid	Fluid secreted by synovial membrane responsible for joint lubrication
Systemic circulation	General circulatory system
Systole	Contraction phase of the heart
Systolic pressure	Blood pressure during ventricular contraction
Tap and talk	The routine for eliciting a response from a casualty who does not respond spontaneously to introductory questions
Tendons	Connect muscle to bone
Tibia	Larger of two lower leg bones
Transverse fracture	Fracture at right angles to the long axis of a bone
Triage	Sorting of casualties according to order of treatment (priority)
Ulna	One of two forearm bones, on the little finger side of lower arm
Unilateral	Affecting one side of body only
Ventilation	The mechanical act of breathing
Ventricles	Pumping chambers of the heart

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